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HISTORICAL REPORT
ATOMIC BOMB TESTS ABLE AND BAKER. ~~SECRET~~
(OPERATION CROSSROADS)

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VOLUME 1 OF 3

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Director of Ship Material, Joint Task Force One

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HISTORY OF DIRECTOR OF SHIP MATERIAL
OPERATION CROSSROADS

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By

Rear Admiral T. A. Solberg, USN,
Director of Ship Material, Joint Task Force One

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PREFACE



The purpose of this history is to provide a general, non-technical introduction to the voluminous technical reports evolving from Operation Crossroads. There are many reasons for such a history but it is enough to say here that any assessment of results in a large test operation must take into account in some manner how the results were obtained. The history, therefore, provides a chronological account of the effort, extending over a period of eight months, which the groups under the Director of Ship Material, as well as some other closely related groups, put forth to obtain the results that lie behind the technical reports.

The scope of the history includes all groups from Army corps and Navy bureaus which either served directly under the Director of Ship Material or gathered data of interest to technical studies made in his organization. This will account for the fact that chapters are included on certain instrumentation groups whose activities were directly re-

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sponsible to the Technical Director. Although these chapters do not give complete chronographies of the activities of the instrumentation groups, they serve to show the means by which measurements were made. Since the relation of instrumentation to damage was stressed throughout the operation, the inclusion of an account of how the instrumentation data were gathered is considered important in assessing the relevance of the damage data. Certain aspects of the work of instrumentation groups could not logically be separated from other groups from the viewpoint of the technical reports; for this reason those aspects are included with the Director of Ship Material history.

The history has another function. Because the many different Army and Navy groups serving under the Director of Ship Material had diverse tasks, each of them wrote historical accounts of their own, which will be, naturally, more elaborate with relation to their work than the account given here. This history serves to tie all of these together and to give a semblance of unity to one of the most complex undertakings in Operation Crossroads.

10 January 1947

↖ T. A. Solberg
T. A. SOLBERG.

INTRODUCTION

ORIGINS OF ATOMIC BOMB TESTS

ORIGINS OF ATOMIC BOMB TESTS

Underwater Explosion Program

On 20 June 1945, when the European war had ended and the Pacific war was approaching its climactic phase, Vice Admiral E. L. Cochrane, Chief of the Bureau of Ships, and Vice Admiral (then Rear Admiral) G. F. Hussey, Chief of the Bureau of Ordnance, addressed a joint letter to the Chief of Naval Operations proposing a comprehensive program for testing high explosives against merchant and warship hulks, captured enemy vessels, and United States Navy combatant ships about to be stricken from the active list. It was desired to go beyond the model studies and full-scale caisson tests which were normally carried on by the two Bureaus. This proposal for "controlled destructive testing in a planned program to elicit fundamental information on damage to ship-like structures by high explosives" met with approval. The two Bureaus and their research agencies sped up the planning

which had already been done to carry out this program. Meanwhile other forces were at work.

The First Three Atomic Bomb Explosions

In the New Mexico desert, near Alamogordo, on 16 July 1945, scientists of the Manhattan District secretly carried out the "Trinity Test" with the first explosion of the atomic bomb, which had been under civilian and military development since July of 1939, when Einstein and other scientists brought the military potentialities of such a weapon to the attention of President Roosevelt. On 5 August, only three weeks after this test, the first military atomic bomb exploded over Hiroshima, and a few days later another atomic bomb exploded over Nagasaki, hastening the Pacific war to its close. The Japanese, faced with this new terror as well as imminent invasion, surrendered unconditionally on 14 August, nine days after the first atomic bomb had been dropped. Even before technical personnel made their studies in Japan, reports of damage at Hiroshima and Nagasaki offered conclusive proof, if any were needed, of the tremendous military potentialities of this new weapon.

Proposal for Ship Tests with Atomic Bombs

On 28 August, the Chief of the Bureau of Ships, Vice Admiral Cochrane, informed his design and research agencies which were planning new programs of underwater explosion work with conventional explosives, that the Bureau of Ships "must be prepared to undertake broad-scale experiments with the atomic bomb to clear up its major influence on naval warfare before we can at all consider an extension of the underwater explosion work on the concept of TNT or its associated explosives." Exploratory discussions on this matter were held with the Chief of the Bureau of Ordnance and other personnel of the two Bureaus.

On 1 October, Vice Admiral Cochrane and Vice Admiral Hussey sent another letter to the Chief of Naval Operations stating that the appearance of the atomic bomb "has made it imperative that a program of full-scale testing be undertaken to determine the effects of this type of bomb, both underwater and above water, against ships of various types." This letter which outlined the problem at considerable length, added that

the two Bureaus would "prepare and present for consideration at the earliest practicable date a testing program with the atomic bomb including specific ship requirements." Requesting that various warships already scheduled for disposal be retained for the atomic bomb tests, the letter pointed out the severe limitations of model work and the need for realistic tests. Certain of the proposed post-war design developments in underwater ordnance and in underwater protection, the letter stated, require "realistic ship targets, either by virtue of the inherent nature of the problem, or to provide adequate guidance so that model work and simplified experiments may be prosecuted intelligently."

Approval of Atomic Bomb Tests

In a letter on 16 October, Admiral E. J. King, Commander-in-Chief of the United States Fleet and Chief of Naval Operations, recommended that the Joint Chiefs of Staff approve a test of the atomic bomb against naval vessels. The Joint Chiefs of Staff undertook study of this proposal. When the

proposal was referred to them, the Joint Staff Planners appointed a planning sub-committee under the chairmanship of Major General Curtis LeMay, Army Air Forces. The Bureau of Ships was represented on this sub-committee by Capt. L. A. Kniskern, the head of its Design Branch. The sub-committee, which first met early in December, submitted a report about a week later recommending that the tests be held, that they be conducted by a Joint Task Force, that the President issue a directive to the War and Navy Departments to conduct the tests, and that the Joint Chiefs of Staff be authorized to appoint a Joint Task Force Commander. The sub-committee also made general recommendations relative to the nature of the tests. The question of appointment of the Joint Task Force Commander was left open, two alternative recommendations being made.

The Secretaries of War and of the Navy made the first public announcement of the proposed tests in a joint press release on 10 December, stating that the Army and Navy contemplated a "joint test of atomic bombs against naval vessels."

Creation of Joint Task Force One

As it was generally understood that the Task Force Commander, if a naval officer, would be Vice Admiral W. H. P. Blandy, the Deputy Chief of Naval Operations for special Weapons, Admiral Blandy took an active interest in the proposed tests during the period of the sub-committee sessions, and increasingly as the time approached for presidential approval, which had been assured. On 10 January 1946, the President approved the recommendations of the Joint Chiefs of Staff essentially as made by the sub-committee; and on 11 January, the Joint Chiefs of Staff created Joint Task Force One, appointing Admiral Blandy as its Commander. Admiral Blandy had already begun specific planning for the two tests, starting with consideration of various proposals for target arrays drawn up by the Bureau of Ships.

On 7 January, a large conference had been held in the offices of the Manhattan District, Army Engineers Building, Washington, D. C. Army, Navy, and Manhattan District representatives discussed the general problems of the tests, giving attention to the

latest sketches of target arrays. Scientists from the Los Alamos Laboratory and personnel from other military and scientific agencies discussed special problems during the same day.

Mission of Joint Task Force One

The mission of Joint Task Force One, which had already been discussed in these conferences, was publicly announced by its Commander on 24 January, when Vice Admiral Blandy told the Senate Committee on Atomic Energy: "The mission of Joint Task Force One is primarily to determine the effects of the atomic bomb upon naval vessels in order to gain information of value to the national defense. The ultimate results of the tests, so far as the Navy is concerned, will be their translation into terms of United States sea power. Secondary purposes are to afford training for Army Air Forces personnel in attack with the atomic bomb against ships and to determine the effect of the atomic bomb upon military installations and equipment." He also announced that the atomic bomb tests had been assigned the code name Operation Crossroads.

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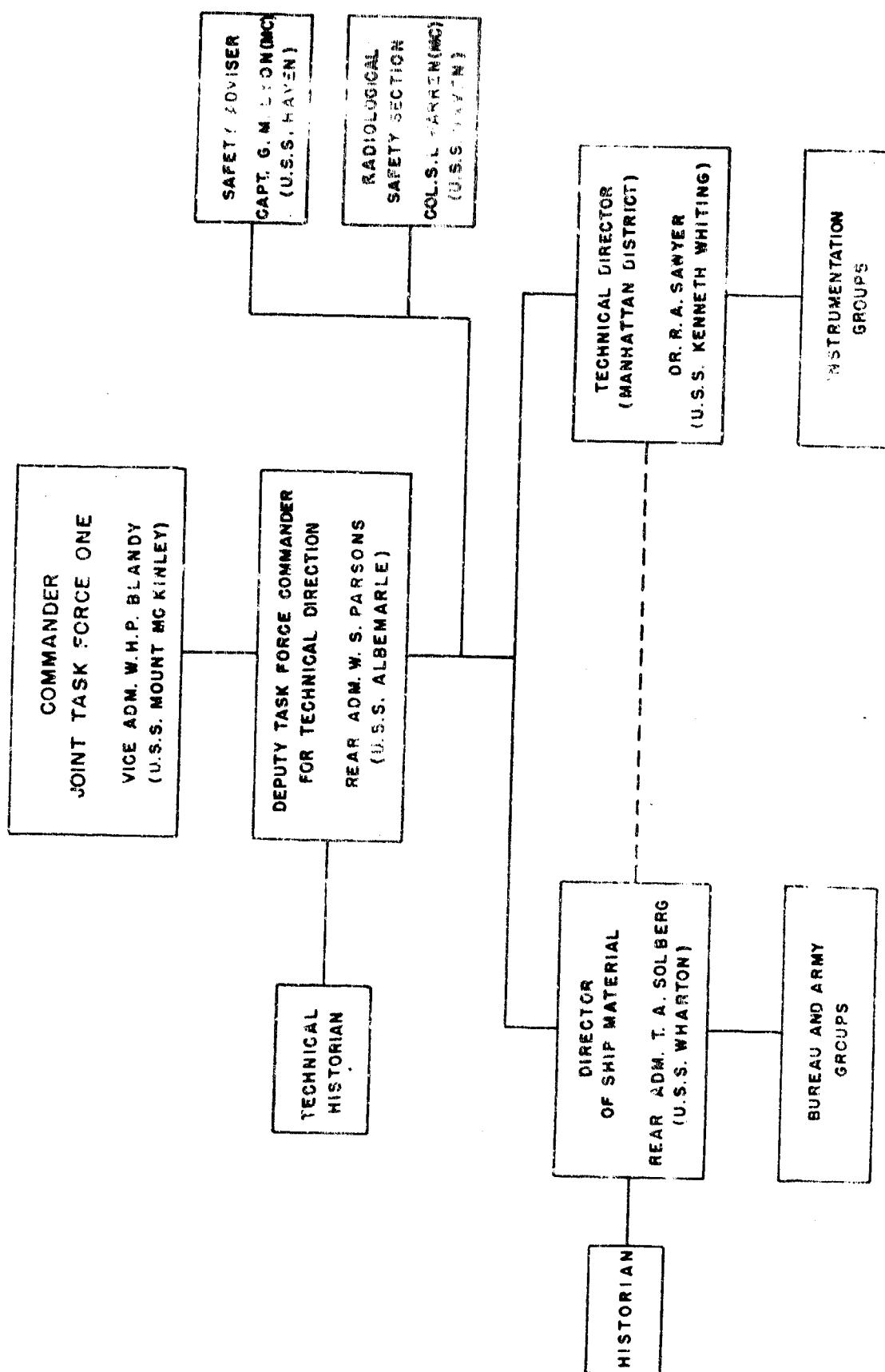
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CHAPTER 1

DIRECTOR OF SHIP MATERIAL

TECHNICAL STAFF OF JOINT TASK FORCE ONE



DIRECTOR OF SHIP MATERIAL

Exploratory Discussions

During this exploratory period, the Chief of the Bureau of Ships, Vice Admiral E. L. Cochrane, who would have a prime concern in any tests of the bomb against naval vessels, had been kept informed of the trend of developments. But the top secret classification of the project permitted very few other officers in the Bureau to know more than the most general facts concerning it; and then, too, the whole project was in such a nebulous state that there was no positive assurance it would be carried through. Around the middle of January, the Commander Joint Task Force One requested that Admiral Cochrane designate an officer with whom he could deal directly and personally on all matters affecting the proposed tests, which by now were called Operation Crossroads. As the Bureau of Ships had a paramount interest in Operation Crossroads, Admiral Cochrane recognized the great responsibility which would devolve upon the officer selected to represent the Bureau and to carry out its extensive and complex tasks. Accordingly, he decided to appoint Rear Admiral T. A. Solberg, head of the Research Branch of the Bureau of Ships, as the senior member of a large bureau group for Operation Crossroads.

Admiral Solberg had been a deputy member of the "Tolman Committee", appointed by Major General Leslie R. Groves in the fall of 1944, almost a year before the "Trinity Test" of the atomic bomb at Alamogordo, New Mexico, to investigate further technical developments in atomic energy for both civilian and military purposes. This committee, under the chairmanship of Dr. R. C. Tolman, had studied many suggestions from personnel connected with the atomic energy projects concerning "the use of nuclear energy for power and the use of radioactive by-products for scientific,

medical, and industrial purposes."¹

On 17 January, Admiral Cochrane called Admiral Solberg and Captain Kniskern to his office and discussed the entire problem with them. He explained that he was appointing Admiral Solberg to this position because it was desirable to have someone of his rank and experience to coordinate all the varied and extensive efforts of the Bureau of Ships and to insure the success of the bureau's work in the project. Admiral Cochrane promised full support, with the assignment of an adequate number of well qualified officers to work full time on the project. He then instructed Admiral Solberg to prepare an administrative order setting up a special section in the bureau to handle Crossroads work. This order, dated 22 January, set up Code 180, the Crossroads Section; and on the same day Admiral Solberg was designated as head of the section and Captain Kniskern as his senior assistant. A number of officers took up duties in the section immediately, and others were added as rapidly as they could be freed from current duties.

Position in Task Force

Meanwhile, Admiral Solberg and Captain Kniskern consulted with Rear Admiral (then Commodore) W. S. Parsons as to the relationship of Admiral Solberg's group to the rest of the Task Force. In the first organization chart prepared by the Task Force, Admiral Parsons was shown as Deputy Task Force Commander for Technical Direction, and under him was the Technical Director, Dr. R. A. Sawyer, in charge of scientific aspects of the tests, particularly the preparation of the bombs and instrumentation to measure their effects. But there was apparently no place in the organization for the primary tasks of ship preparation and inspection. Admiral

¹See H. D. Smyth, Atomic Energy for Military Purposes, (Princeton, 1945), pp. 224-5.

Parsons was quick to recognize the necessity for broadening the organization to include the vast amount of technical effort required outside the field of scientific instrumentation, but closely related to it. Accordingly, Admiral Solberg was assigned a place in the organization parallel to that of the Technical Director.

This assignment was made because it had become apparent that there must be central control over all the materials on the target ships, whether normal materials or those placed aboard for test purposes, including special instruments. In other words, it was essential for one agency to coordinate all of the problems relating to the target ships themselves including special test materials on the ships. Admiral Solberg received this overall technical responsibility. It then remained to select a title for this position. When the title "Director of Ship Material" was proposed, Admiral Parsons and Admiral Blandy agreed; and henceforth this title appeared in the Joint Task Force One organization charts, under Admiral Parsons, the Deputy Task Force Commander for Technical Direction, and parallel to Dr. Sawyer, the Technical Director. It was agreed that all instrumentation would be subject to the Technical Director's approval, but that the Director of Ship Material would have a major interest in problems involved in locations of instruments on target ships and in their installation, as well as in the results they gave with reference to ship damage. It was therefore agreed that the closest liaison between the Technical Director and the Director of Ship Material would be necessary.

Formation of Staff

Many representatives of various Navy bureaus and Army Ground and Air Forces, who had been involved in the early planning of Operation Crossroads, found their appropriate place in Joint Task Force One on the staff of the Director of Ship Material when that organization was created in late January with the code designation 014. Most of the staff members reported to the Director of Ship Material before

1 February. Capt. L. A. Kniskern reported as head of the Bureau of Ships Group (014-K), remaining in that position until shortly before Test Able when he became Deputy Director of Ship Material, being relieved by Capt. F. X. Forest, a member of the Bureau of Ships Group. Even during the early stages, however, Captain Kniskern, as first assistant to Admiral Solberg, served to all intents and purposes as a deputy director. Col. J. D. Frederick reported as head of the Army Ground Group (014-B), which included personnel from the Quartermaster Corps, Signal Corps, Ordnance Department, Chemical Warfare Service, Air Corps, and Corps of Engineers. Capt. T. C. Lonnquest joined the staff as head of the Bureau of Aeronautics Group (014-J). Capt. E. B. Mott became a member of the staff as head of the Bureau of Ordnance Group (014-L). Capt. R. H. Draeger (MC), head of the Naval Medical Research Section (014-M2), joined the Director of Ship Material staff, as great stress was being laid on animal studies aboard the target ships. Capt. O. Schneider (MC), reported around the middle of February as head of the Damage Control Safety Section (014-M1), which had been created by the Safety Adviser for determining non-radiological hazards. An officer from the Electronics Group, Comdr. F. X. Foster, was assigned to the staff early in February as Special Assistant in Communications. Early in March, the Bureau of Ships ordered its historian to report to the Director of Ship Material for duty, as he was designated historian for the Director of Ship Material.

Two other bureaus were minor participants. The Bureau of Yards and Docks in early March provided a small group (014-Y), under Comdr. Raymond Lamoreaux, (CEC), which had a structural interest in three steel-reinforced concrete vessels in the target array. The Bureau of Supplies and Accounts, which was interested in normal ships' stores, in May provided a small group (014-S), under Lieut. Comdr. O. W. Fraser, (SC).

Relation to Instrumentation Groups

Instrumentation groups from the Bureau of Ships, while responsible to the Technical Director (013), performed duties on the staff of the Director of Ship Material, as he was responsible for all Bureau of Ships activities in Operation Crossroads. Comdr. C. H. Gerlach, head of the Ships Instrumentation Group (013-C), had been engaged in the underwater explosion research program of the Bureau of Ships from which much of the ship instrumentation evolved. Comdr. Roger Revelle, head of the Oceanography Group (013-B), who had been in charge of a special oceanographic program in the Bureau of Ships, served on the staff. Capt. C. L. Engleman, head of the Electronics Group (013-D), drawn largely from the Bureau of Ships with additional personnel from the Army Ground Group, the Bureau of Ordnance Group, and the Bureau of Aeronautics Group, was a member of the staff. Comdr. R. M. Langer, a member of the Ships Instrumentation Group, joined the staff as head of the Ships Technical Photography Section (013-K2) when it became apparent that groups under the Director of Ship Material had major technical photography requirements. The Bureau of Ordnance Instrumentation Group (013-G) was headed by Comdr. Stephen Brunauer during the planning phase in Washington. Shortly before departure from Washington, Captain A. E. Uehlinger, relieved Comdr. Brunauer in this position. Close coordination of the activities of this group with other instrumentation groups and with all groups of the Director of Ship Material Staff was essential, not only for the purpose of assuring adequate scientific information, without duplication, but also for the purpose of assuring efficient and effective efforts in the target preparation and in the actual conduct of operations at Bikini.

Relation to Operational Units

The Director of Ship Material had to maintain close liai-

son with several operational units within the Task Force. The Instrumentation Unit (Task Unit 1.1.2), which for operations after Pearl Harbor was under Capt. A. C. Thorington, included ships quartering various groups of the Technical Staff of the Task Force. The Director of Ship Material, embarked in WHARTON, had groups in HAVEN, BURLESON, AVERY ISLAND, and KENNETH WHITING, all of which were in the Instrumentation Unit. All target ships were under the operational control of Rear Admiral F. G. Fahrion, who as Commander Target Vessel Group (Task Group 1.2), was responsible for the movement control, loading, and stores and personnel requirements of these ships throughout both the preparation period and the test period. Since ships' movements and loading affected the work of preparation of the targets, it was necessary for the Director of Ship Material to work closely with the staff of Commander Target Vessel Group especially during the period prior to his arrival at Bikini. A unit that was of much assistance to the Director of Ship Material, particularly in mooring incident with establishing the target arrays, and in salvage and firefighting operations after the tests, was under the Commander Target Vessel Group and was designated the Salvage Unit (Task Unit 1.2.7) under Capt. B. E. Manseau. The ships in this unit were used during test operations to transport the Initial Boarding Teams. A Service Group (Task Group 1.8), comprising Service Division 11 of the Pacific Fleet, under Capt. G. H. Lytle, was assigned to the Task Force to perform repair services in the Bikini area. This group assisted the Director of Ship Material in final pre-test ship preparations and in much of the post-test repair work.

Responsibility

Many of the Army and Navy groups in Operation Crossroads, had dual responsibilities, on the one hand to their respective parent organizations, on the other to the Task Force itself. The heavy involvement of the Bureau of Ships, which went beyond the target ships themselves to include

special interests in electronics, oceanography, ships instrumentation, and explosion phenomena, made the tasks of the Director of Ship Material diverse and complex. On the one hand, Admiral Solberg was responsible for all Bureau of Ships activities in Operation Crossroads, including special projects like the oceanographic instrumentation which was to be provided for the most part in the water rather than on the target ships themselves. On the other hand, he was responsible for all the target ships as well as for all the materials and installations on those ships, and for close liaison with the Technical Director on all instrumentation problems affecting the target ships. The installation requirements of the instrumentation groups had to be coordinated initially by the Director of Ship Material and finally in liaison with the Technical Director.

The Director of Ship Material was responsible for directing the work of the groups under him, which represented various Army corps and Navy bureaus concerned with the effects of the atomic bomb on ships, aircraft, ordnance, supplies, equipment, and animal life. The nature of this work was set forth as Annex W to the Operation Plan.¹ The consequent inspections were outlined in Annex X.² These two annexes comprise a substantial part of the technical effort in Operation Crossroads. Two lengthy and detailed appendices to Annex W, dealing with special matters of concern to the Bureau of Ships Group and the Bureau of Ordnance Group, were published separately as the Director of Ship Material's

* ¹See Annex W: Ship Preparation Plan.

* ²See Annex X: Reboarding and Inspection Plan.

* Note: References from OPERATION PLAN,
ComJointTaskForOne No. 1-46.
See Bibliography, Appendix I.

Instrumentation groups, such as those for electronics, ships, ordnance, oceanography, and technical photography, while directly responsible to the Technical Director, were dependent to varying degrees upon the Director of Ship Material for facilities and assistance. In brief, the Director of Ship Material was responsible for mounting on the target ships and the material to be tested on them, for supporting the instrumentation effort, and for obtaining all the test data that affected the interests of the groups directly under his command. There were additional routine responsibilities such as the preparation of the 130 non-target vessels necessary for the operation.

Staff for Technical Inspections

The Army and Navy groups under the Director of Ship Material carried on the work of ship preparation, both in Washington and in field activities such as proving grounds and naval shipyards, from February through May, with some final work at Bikini in June. The Director of Ship Material staff embarked in U.S.S. WHARTON, the headquarters ship on 4 May, at Oakland, California, proceeding on 6 May to Pearl Harbor enroute to Bikini Atoll. Now that the lengthy preparation phase was virtually over, the task of inspection began to assume major importance; and the Director of Ship Material staff aboard WHARTON was reorganized for this task. I had been foreseen before departure from Washington that the physical shift to the target area, with new problems

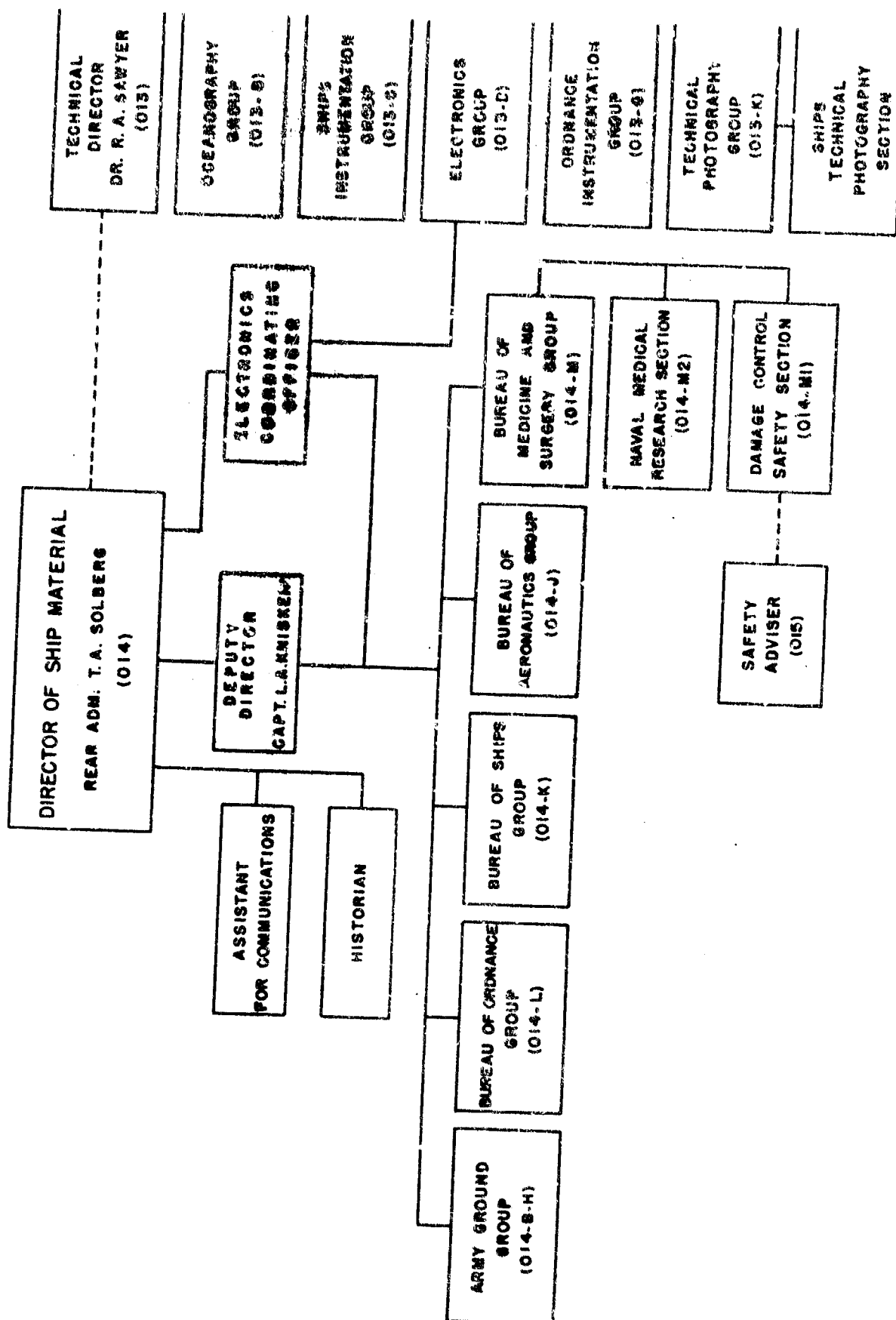
¹Instructions to Target Vessels for Tests and Observations by Ship's Force (BuShips).

²Instructions to Target Vessels for Tests and Observations by Ship's Force (BuOrd).

of movement, communications, safety, and inspection control, would require a reorganization of the staff. Upon departure of WHARTON from Pearl Harbor on 22 May, Captain Kniskern was designated Deputy Director of Ship Material, and Captain Forest became head of the Bureau of Ships Group, which was now to concentrate upon final preparation of the target ships. The heads of all groups were closely integrated for the task of technical inspection. Capt. R. C. Bell was designated as Target Preparation and Inspection Officer in charge of coordinating inspection activities of the various groups. Paralleling this officer was the Planning Officer, Capt. F. W. Slaven, who directed administrative matters, communications, technical activities, and safety. A third section, called Field Analysis and Technical Review, was headed by Capt. T. C. Lonnquest, with the heads of the various groups serving as members. In this way the separate group organizations were integrated into the Director of Ship Material staff to carry out planning, inspection, and analysis in the target area; and the reorganization, dated 19 June, appeared in the Operation Plan.¹

¹See Annex X, App. I, Table 1:
Target Ship Inspection Control Organization.

DIRECTOR OF SHIP MATERIAL (O14)



DEVELOPMENT OF TARGET ARRAY

Preliminary

The number and disposition of target ships for the atomic bomb tests were matters of such fundamental importance to all activities concerned in the test that it was necessary to subject all proposals to the closest examination and to obtain opinions and comments from all of these activities before the final target arrays could be approved by the Joint Chiefs of Staff. In the end, of course, it was necessary to adopt compromise solutions which, however, were reasonably satisfactory to all concerned.

Even during the period of preliminary discussions by the special sub-committee of the Joint Staff Planners it was necessary to have some approximate conception of a feasible target array. The Chief of Naval Operations had made certain ships available for explosion testing and later specifically for the atomic tests. With a knowledge of the characteristics of the available ships, and a broad background of experience from war damage analysis and controlled tests, it was natural and logical that the Bureau of Ships should take the first steps in attempting to formulate a target array, and should play an important part in all subsequent developments of target arrays.

At the time that the atomic bomb tests were under consideration by the Joint Staff Planners, it was considered desirable to have three tests - one with the bomb burst in air above the target array, one with the bomb burst at the surface of the water, and one with the bomb burst at the surface of the water, at an unspecified depth. The characteristics of the bomb were not known to the Bureau of Ships: hence assumptions as to damage had to be based on the published statement that the bomb was approximately equivalent to 20,000 tons of TNT. Summarizing, the first studies of target arrays made by the Bureau of Ships in December 1945 were based on the following:

- (a) Knowledge of ships which probably would be available for the tests.

- (b) Knowledge of characteristics of those ships.
- (c) Very rough estimates of damaging effects of 20,000 tons of TNT, based on war experience and testing experience with much smaller charges.

Early Plans and Philosophy

The first sketch, prepared by the Bureau of Ships before 19 December 1945, nevertheless, had some of the characteristics of the final target arrays. The first and the most important of these features was the use of relatively large numbers of merchant type vessels and destroyers to provide "gross gauges" of damage effects. Secondly, some ships placed close to the center were expected to be sunk or just short of being sunk, while others at extreme range were expected to be essentially undamaged, and those in between were to show gradations of damage between maximum and minimum as finally required by Joint Chiefs of Staff. Thirdly, the destroyers and merchant-type vessels were arranged in approximately radial-lines, out from the center, with two orientations, end-on and beam-on, toward the center.

Certain basic differences from later lay outs will be noted, however. In the first place, it was assumed that all target vessels would be moored bow and stern to obtain desired orientations.

Secondly, it was assumed that the ranges of interest for the three tests would be approximately the same, so one sketch was used for all three tests, with notes covering the target shifts which probably would be required as a result of damage from each of the first two tests.

First Sketches

No prints were made of Sketch No. 1, and the original was used for developing changes during the period from 19 December to 3 January: hence it bears the date of 3 January.

(No. 2 was assigned to a small tracing paper overlay containing the center of the array for the air burst test; this was later put on Sketch No. 3 in dotted indication).

Sketch No. 1 was discussed informally with Admiral Blandy, and also with the Chief of the Bureau of Ships, Admiral Cochrane. As a result of these discussions and other developments during this period it was decided, at least tentatively, to make the following changes, which were incorporated in Sketch No. 3:-

(1) As soon as Bikini Atoll was selected tentatively as the site of the tests, the center of the target array was located as close to Bikini Island as was considered practicable at the time.

(2) Twelve landing craft were placed on the island, beached, although these had not been made available by the Chief of Naval Operations.

(3) PRINZ EUGEN, NAGATO and SAKAWA were added.

(4) It was considered out of the question to moor all ships, hence simple anchoring was shown.

(5) It was considered necessary to place an aircraft carrier as the aiming point for the air test.

(6) It was considered necessary to place the other available aircraft carrier, a submarine and a battleship at distances from the surface burst (second test) which were within the estimate of mean radial bombing error. Mooring of these targets bow and stern was essential.

(7) It was desired to have a closer grouping of ships toward the center for the air burst test, so as to insure that major combatant vessels would be close to the explosion, even with maximum bombing errors.

(8) Battleships and cruisers were re-arranged to afford a better distribution with respect to pairing in orientation.

Early Changes

Sketch No. 4 dated 8 January, was essentially like No. 3 except that the center of the array was brought closer to Bikini Island so that the ground installations proposed at that time would be exposed properly, and also to provide a shorter range desired by the Los Alamos Group at that time for instrumentation purposes.

Sketch No. 4 was in effect at the time of the first meeting with Los Alamos personnel who had at hand information regarding the air blast and shock wave intensities to be expected. This information did not materially change views toward the surface test; but figures showed that for the first test, the air blast intensities would decay with distance more rapidly than has been the guess, and this information became a factor in the progressively closer grouping of target ships around the center for Test Able. In Sketch No. 5, dated 10 January, the major combatant ships were moved closer toward the center. In order to close in the immediate center for Test Able, the point-of-aim carrier was changed to be moored bow and stern, instead of anchored, thereby enabling the four surrounding ships to be moved closer in. For Test Baker, the close-in battleship and submarine were interchanged in position to place the battleship broadside to the explosion. Other changes added various landing craft beached on Bikini Island, and several destroyers were spread out in the easterly sector to insure an adequate coverage with respect to radioactively contaminated spray, which could be expected in this sector in Test Baker. Finally, it had been decided to submerge five of the submarines in Test Baker.

Sketches for Each Test

At this time, plans were proceeding on the basis of only two tests - an air burst and a surface test as the Los Alamos Group considered that only two tests would be feasible in 1946, and that a surface burst was preferable to a shallow underwater burst in Bikini Lagoon.

By the middle of January, it had become obvious that the requirements for ship locations in the two tests would diverge to a greater degree than first thought. From here on, the sketches were treated separately for Tests Able and Baker. Sketch Nos. 8 (Test Baker) and (Test Able), dated 23 January, offered no major changes except that five heavy hull submarines had been made available as a result of the importance with which the future role of the submarine was regarded in many quarters. The submarines previously available were in all cases submarines which were being retired from active patrol service in the later months of the war. Modern designs were desired in the target array wherever possible, and it was possible to use modern submarines. Three light hull vessels were still retained in the target array, permitting a direct comparison between the two types. For Test Able, the point-of-aim CV was replaced by a CVL, as the U.S.S. RANGER had been taken away for operation needs.

Modifications for Both Tests

Sketches No. 8 (Test Baker) and No. 9 (Test Able), dated 25 January, incorporated two major changes. First, in order to avoid a cluster of coral heads that would interfere seriously with the desired placing of the target ships, the center of the array was shifted some distance southwest to an area much less densely populated by coral heads. Second, ships on the 1,500 yard circle and within were intended to be moored bow and stern with a spare anchor abeam in order to have some assurance against the complications and uncontrolled damage which might result from a number of ships being adrift.

There were two minor changes. First, ships of the center group for Test Baker were moved somewhat farther out than their original station. Although it was considered a prerequisite to sink these ships, it was felt that at this range the sinking would contribute nothing; because anything so close probably would be damaged beyond hope of

gaining useful knowledge. Secondly, for Test Able, the center grouping ships was modified to facilitate instrumentation techniques aimed at determining shock wave velocity, and for both tests, ships were added relatively close to the center on a line toward Bikini to facilitate these measurements.

Sketches No. 10 (Test Baker) and No. 11 (Test Able), dated 28 January, comprised only slight modifications of the previous issues. For Test Able, the locations of the center group of ships were changed slightly to achieve a more favorable target distribution from the standpoint of random bombing dispersion. For Test Baker, locations were provided for all ships used in Test Able, contingent upon their survival of the first test.

Sketches No. 12 (Test Baker) and No. 13 (Test Able), dated 31 January, were the result of a conference of Commander Joint Task Force One, his Deputy Task Force Commander, his adviser for Army Ground Forces, the Military Advisory Board to the Commanding General of the Manhattan District, General LeMay, and representatives of the Bureau of Ships and the Bureau of Ordnance. The points raised principally concerned filling in the gaps that existed inside 1,000 yards and providing a more symmetrical distribution of targets by placing ships in the easterly sectors. The specific points agreed upon were incorporated in Sketch Nos. 12 and 13, and sent to various of the conferees for further study.

Further Adjustments

Sketch No. 14 (Test Able), dated 8 February, was affected by several developments. First, the plan for bow and stern mooring of ships, with a spare anchor abeam for ships at 1,500 yards or less, fell through because of technical difficulties and shortage of ground tackle, so that plain anchoring had to be relied upon as much as possible. In this connection however, it was decided for Test Baker, to provide for dropping a second anchor with chain looped up in bights to hold the ship in case the first chain parted. Secondly, more accurate and consistent figures became available for the air

blast properties, and these supported a demand for even denser grouping of ships around the center, especially within 1,000 yards. In this connection, Dr. W. G. Penney and Sir Geoffrey Taylor brought forward specific proposals for placing major combatant ships in a sort of pentagonal arrangement around the point-of-aim to improve the range distribution under the random bombing dispersion expected. These proposals, which were substantially accepted, conditioned the grouping especially within about 1,000 yards. Thirdly, although the Army Air Forces originally had desired an aircraft carrier as a point-of-aim for the bombing plane, they proposed at this time that the center ship should be the heaviest and most resistant ship available. PENNSYLVANIA was therefore shown in the center position in Sketch No. 14. Finally, preliminary comments from Army Air Forces suggested a better spreading of ships to the north and east, and suggested that the submarines be closed in to give a more rigorous testing of those vessels; both of these suggestions were adopted.

Sketch No. 15 (Test Baker), dated 8 February, followed the changes of Test Able respecting the submarines and the landing craft fanned out to the north and east. It included minor adjustments around the center as a consequence of abandoning the mooring scheme previously mentioned.

Mooring and Loading Problems

Sketch No. 16 (Test Able), dated 9 February, was an outgrowth of compromises resulting from an Army Air Force proposal to pack ships more closely around the center than would be practicable from simple considerations of mooring problems. A mooring scheme proposed by Rear Admiral F. G. Fahrion, USN, Commander Task Group 1.2, was adopted to permit the densest array practicable within 500 yards. Because of the complexities of the moorings and the limitations on ground tackle supply, ships beyond 500 yards were to remain anchored. At this time, NEVADA was substituted for PENNSYLVANIA at the center of the array, because

PENNSYLVANIA had some damage near the stern, from a torpedo hit suffered during the war and this had been repaired only by a temporary patch. The basic directive required gradation of damage from maximum to negligible, and it was therefore considered necessary to place at least one battleship at a point where damage would probably be slight, and another at an intermediate range. PENNSYLVANIA was selected for the former location, NEW YORK for the latter.

Up to this time the Bureau of Ships had proposed, with respect to the loading of the target vessels, to provide sample loading of fuel and ammunition as a means of studying what effects these materials might have. In a discussion of this edition of the target array with the Military Advisory Board to the Commanding General of the Manhattan District, the representatives of the Manhattan District and Army Air Forces proposed full loading of both fuel and ammunition. The actual fuel and ammunition loadings used were the result of a compromise reached on this subject. The decision also was made to assign the lesser quantities to ships upwind in the array to reduce the damage of a possible conflagration of fuel on the surface drifting down over the array. The loadings were carried over to the same ships in their position in the Test Baker array.

At this time it was necessary to determine upon specific ships of all types by name and location in order to enable necessary work on target ships to proceed.

Late Developments

By the middle of February, the target arrays for both Tests Able and Baker were in a reasonably firm condition, and only minor changes had to be made before they reached their final form. Sketch No. 16A (Test Able), dated 15 February, showed SALT LAKE CITY and ARKANSAS moored with two anchors at the bow to permit their being closed in toward the center.

Sketch No. 16B (Test Able) (20 February) showed a destroyer moved in somewhat closer than its original station

at 700 yards, SARATOGA anchored at about one mile, and another destroyer brought in from the rim of the array to about 1,500 yards.

Sketch No. 17, dated 11 February, showed ARKANSAS and SALT LAKE CITY moored bow and stern to enable the 1,000 yard circle to be packed tight with ships, with additional destroyers and auxiliaries placed inside the circle. The submarines, except PARCHE, were moved to the northeast quadrant to reduce the possibility of undue complications to their role in Test Baker from oil fires in the Lagoon. The line of destroyers in the northwest sector was opened up in spacing to put the head of the string 200 yards closer in. This sketch was approved by the Joint Chiefs of Staff for Test Able, but certain changes were later found necessary and approved.

Final Target Array for Test Able

The following changes from the approved sketch, were approved and incorporated in the actual array of ships used in Test Able:-

(a) Late in April, 1946, the Chief of Naval Operations requested the Commander Joint Task Force One to reduce the number of ships involved in Operation Crossroads to accomplish the maximum practicable saving in personnel. Accordingly, it was decided that the following changes could be made without serious effects on the value of the tests:-

(1) Omit destroyers HELM and SMITH, and substitute for them LCT's 1013 and 705. These destroyers had been included in the array primarily to serve as "rain catchers" to collect samples of any fission products which might fall out of the atomic cloud in that down-wind sector of the array. It was decided that the LCT's could fill this role equally well.

(2) Omit CLEBURNE (APA 13) and substitute GASCONADE (APA 85), thus saving one vessel as it was agreed that CLEBURNE could be omitted from Test Baker also without serious effect.

(b) LST 388 was omitted because it was needed by Task Group 1.8, and LST 220 was transferred from a position on the beach to the former position of LST 388.

(c) The following substitutions were made because of poor material condition of the vessels omitted:-

- (1) LST 661 substituted for LST 283.
- (2) LCT 1175 substituted for LCT 845.
- (3) LCT 1237 substituted for LCT 412.

(d) MAYRANT was substituted for FLUSSER because FLUSSER's machinery was in better condition than MAYRANT's for use in the destroyer patrol on Able Day and Baker Day.

Final Target Array for Test Baker

Sketch No. 15 became the approved array for Test Baker, ~~subject to an understanding~~ with the Joint Chiefs of Staff that modifications would undoubtedly be necessary as a result of experience with Test Able, as well as for other reasons. At that time, Test Baker was scheduled to be a surface shot, but investigations were made of the feasibility of firing this shot below the surface. When it developed that this would be feasible without appreciable delay in the tests, agreement was general in favor of the underwater shot and a recommendation for this was submitted to the Joint Chiefs of Staff and approved by them. At about the same time, a revised target array was submitted to the Joint Chiefs of Staff, with the following note on the plan:- "The array shown is the approved array for Test Baker in the event Test Able will have been postponed, and is the basic scheme to be adjusted as appropriate if Test Able will have been conducted".

This array as finally approved, included the following changes.

(a) To provide closer grouping near the center.

(1) PENNSYLVANIA and SALT LAKE CITY were moved in thus requiring RALPH TALBOT to

be moved outward about 300 yards.

(2) The positions of NAGATO, SAKAWA and INDEPENDENCE were changed to fill in as closely as possible the area within 1500 yards in the northeast sector.

(b) To save personnel by reducing the number of ships, as requested by the Chief of Naval Operations.

(1) FERGUS and CLEBURNE were omitted.

(2) SMITH, HELM, and BAGLEY were omitted, with LCT 1013 and LCT 705 substituted for SMITH and HELM.

(c) LST 133 was moved in from the beach to the former position of LST 220.

(d) LST 388 was omitted and LST 220 substituted for it for the same reason as given above for Test Able.

(e) ARKANSAS was moved at the request of the Joint Chiefs of Staff.

Changes Resulting from Test Able

After Test Able, a staff conference was held to discuss desirable changes in the target layout for Test Baker. This conference was attended by the Joint Chiefs of Staff Evaluation Board and representatives of the Manhattan District, in addition to the regular attendance of the Staff. As a result of this conference, changes were recommended to the Joint Chiefs of Staff and were approved as follows:-

(a) Substitute MUSTIN for SAKAWA (Sunk in Test Able) on same bearing. Replace MUSTIN by HUGHES, which was not in the original array. These changes provided another opportunity for obtaining graduated damage on hulls of the same type.

(b) Interchange positions of RHIND and WILSON. It was thought that RHIND might have some weakening of structure from Test Able and a less lethal position was desired because of instrumentation carried on RHIND.

(c) Interchange position of SALT LAKE CITY and INDEPENDENCE. INDEPENDENCE had severe damage above the waterline at the stern, and afforded greater probability of furnishing use-

ful information with her bow presented toward the explosion.

(d) Substitute BRULE, not originally in Test Baker, for GILLIAM, sunk in Test Able.

(e) Interchange positions of CRITTENDEN and DAWSON, for the same reason as in item (b) above.

(f) Move GASCONADE to southwestward about 500 yards and place FALLON between BRULE and ARKANSAS, in order to provide better coverage of the area between the 500 yard and the 750 yard circles.

(g) Substitute CONYNGHAM for ANDERSON, sunk in Test Able and place LCT 1115 in previous CONYNGHAM berth: leave LCT 816 in Test Able position replacing LCT 1115, in order to utilize instrumentation already installed in LCT 816.

(h) Move PENSACOLA to bearing 250°, at original range, to permit moving the submarines APOGON, SKIPJACK, DENTUDA, SEARAVEN, and TUNA each toward about 300 yards. Moor APOGON submerged at or below bomb depth. The other four submerged submarines were to remain at periscope depth. Place SKATE on surface bearing about 220 degrees, range about 700 yards; the damage to topside structure and fittings prevented mooring SKATE submerged, although the pressure hull was sound.

(i) Move SARATOGA nearer the outer limit of lethal area, thereby providing better graduation of distances between ARKANSAS, SARATOGA, NEVADA, NEW YORK and PENNSYLVANIA. This also made it probable that SARATOGA would sink more slowly, permitting photographic studies of overall damage, particularly the behavior of the flight deck.

(j) Place LST 125 on beach, in order to have the LST's represented among the beached landing craft.

(k) Add LCT 818 at 1700 yards on bearing 035° to provide additional instrumentation desired specifically in this location.

Note: The originals of the various sketches referred to herein are available for study in the Bureau of Ships, Code 424, and copies are also available in the files of the Historian, Joint Task Force One.

PREPARATIONS FOR THE TESTS

Preliminary

There were a number of problems which immediately confronted the Director of Ship Material as soon as various Army and Navy groups were organized under his command. The ships which had been made available by the Chief of Naval Operations as targets were scattered in continental and overseas naval shipyards, and it was necessary to obtain firm information on their whereabouts. An overall plan had to be made effecting an orderly distribution of these ships among different naval shipyards, as their preparation would be a major task far beyond the capacity of any single yard. In many cases considerable repair work would have to be done to enable the ships to steam to Bikini and maintain themselves there. The location of instruments and test materials aboard the target ships would depend upon the positions of the ships in the target array, which was in a transitional state, undergoing frequent changes for military or technical reasons. The time limit was short to the point of urgency, with only about three months for preparing ships, materials, and instruments for the first test, which had been set for 15 May. All these interlocking factors were operating simultaneously, and they increased the difficulty of what would have been in any case a naval construction task of the first magnitude.

Assembling of Target Ships

Prior to the Director of Ship Material's first staff conference on 22 January, the forces afloat had already sent out orders for all target ships to proceed to Pearl Harbor by 5 April. This was obviously going to create a serious bottleneck at Pearl Harbor; accordingly, the Director of Ship Material arranged for the cancellation of all previous sailing

orders to certain ships in continental shipyards, so that they might remain in these shipyards and be prepared before arriving at Pearl Harbor. It developed that all the major combatant ships were prepared at naval shipyards on the West Coast, with the exception of NEW YORK and PRINZ EUGEN, which were held in Philadelphia. Most of the non-target auxiliaries were prepared in continental shipyards, principally on the West Coast. Target destroyers, submarines, landing craft, and auxiliaries assembled at Pearl Harbor. The Japanese battleship NAGATO and cruiser SAKAWA, originally scheduled for preparation at Pearl Harbor, were finally prepared by a repair ship at Bikini, after arriving there late in April following several changes in orders.

Departure of Advance Units

During the latter part of January and early February, the ship preparation units prepared detailed instructions, covering all types of target ships, which were dispatched to the ships themselves and the naval shipyards preparing them. By the middle of February, this planning had progressed to the point where it was found desirable for the Director of Ship Material to send representatives to the various shipyards to assist in the preparatory work and to inspect the ships. The first of these departed Washington on 8 February to expedite non-target conversions on the West Coast; others followed on 16 February to coordinate the destroyer, auxiliary and landing craft program at Pearl Harbor. Later in February, representatives of the unit for combatant ships, comprising battleships, carriers, and cruisers, proceeded to the West Coast, where officers were assigned to the various naval shipyards preparing the major target ships. The submarine representatives left on 2 March for Pearl Harbor to assist in preparing the target submarines.

Crossroads Work on West Coast

The senior Crossroads representative for the West Coast, Captain Maxwell, organized his unit at the Naval shipyard at Terminal Island, after arriving there on 22 February. As additional personnel arrived from the Bureau of Ships Group in Washington, he appointed Crossroads representatives for the naval shipyards at Puget Sound and San Francisco. These two shipyards were preparing PENNSYLVANIA and SARATOGA, respectively, and the remaining ships, NEVADA, ARKANSAS, INDEPENDENCE, SALT LAKE CITY, and PENSACOLA, were at Terminal Island. Later work on PRINZ EUGEN was also done at Terminal Island. The first of a series of weekly conferences was held on 26 February with the commanding officers, or their representatives, of the West Coast target ships, as a means of explaining the nature of the tests, passing on instructions from the Bureau of Ships Group, and assisting in ship preparation work. On 5 March, Captain Creasor arrived at Terminal Island Naval Shipyard from Washington and commenced inspections of the target ships at West Coast yards and at Pearl Harbor, particularly in regard to electrical plants and special electrical materials installed for the tests. As the yards completed the assigned preparatory work and the combatant ships proceeded to Pearl Harbor in early May, remaining West Coast representatives rejoined the staff in WHARTON at Oakland, California.

Crossroads Work at Pearl Harbor

Captain Bell, the senior Crossroads representative for Pearl Harbor, arrived there on 27 February, along with Capt. E. W. Lamons, machinery assistant, and other staff personnel; and a conference was held on the same day with representatives of the naval shipyard, the Service Force of the Pacific Fleet, and the Army. All the target destroyers, submarines, landing craft and auxiliaries had been assembled

at Pearl Harbor for preparation. The submarines were prepared at the submarine base under the direction of Commander Gaasterland, who arrived at Pearl Harbor on 4 March as head of the Crossroads submarine unit. Regular conferences were held with the commanding officers of destroyers and of auxiliaries and landing craft, which formed two groups of target ships being prepared at the naval shipyard. The Crossroads unit included special assistants for hull, machinery, electrical equipment, electronics, and ship measurements, plus a considerable number of Ships Instrumentation personnel, and representatives of the Bureau of Ordnance, Bureau of Aeronautics and Army Ground Groups. The Unit concluded this preparatory phase during the middle of May, when the target ships departed for Bikini, and the members of the unit assumed their assignment on the Director of Ship Material Staff in WHARTON.

Postponement of Tests

On 23 March, the Commander Joint Task Force One publicly announced that the tests had been postponed for six weeks by direction of the President of the United States and that the date of the first test, which had been scheduled for 15 May, would now be 1 July. In his conference on 20 March, the Director of Ship Material had informed his groups that all preparations were well in hand, with the departure date from Washington by special train set for 29 March. After the postponement, the Director of Ship Material held a special conference with his staff on 25 March to review the situation. Major target ships were being held on the West Coast. Sailing orders of WHARTON and other non-target ships had been cancelled. NAGATO and SAKAWA, instead of proceeding directly from Japan to Pearl Harbor, were being diverted to Eniwetok. A tentative interval between tests, Admiral Solberg stated, was under study; and he directed his groups to make reports on their estimate of how much time would be required between tests for them to do their work. The effects of the postponement were also discussed in another confer-

ence on 27 March. More time was now available for studying details of organization, making further preliminary inspections, and submitting history material; meanwhile all work was to proceed without any slackening of effort. It was now possible to plan on a ten-day stopover in Pearl Harbor enroute to Bikini Atoll. The availability of many of the target ships would allow for considerable instrumentation work which otherwise would have had to be done under less favorable conditions in the target area, and would permit observers to become familiar with the target ships.

Preliminary Inspections by Groups

Starting with the first visits to NEW YORK at Philadelphia Naval Shipyard in late January, heads of groups or their representatives made preliminary inspections of the progress of ship preparation work until the departure of the Director of Ship Material staff in May. The general purpose of these inspections was to insure that the ship preparation work was done in conformity with the detailed instructions of Annex W and special instructions contained in Director of Ship Material Memoranda. During the second week in March, the head of the Bureau of Aeronautics Group, Captain Lonnquest, inspected SARATOGA and INDEPENDENCE on the West Coast, as well as other target ships carrying aircraft. The executive officer of the Bureau of Ordnance Group, Commander Freedman, went to the West Coast around the middle of March to check the progress of ordnance work. The head of the Army Ground Group, Colonel Frederick, made inspections on the West Coast early in April of the loading of Army equipment on target ships. Captain Forest, representing the Bureau of Ships Group and the Director of Ship Material, made a last-minute inspection of target ships on the West Coast and at Pearl Harbor during the middle of April, not long before the staff was to depart from Washington. These preliminary inspections, along with numerous others which had been made, were to be supplemented by inspections of the target ships at Pearl Harbor; and then the last prelimi-

nary inspections could be made after the target fleet assembled in Bikini Lagoon.

Departure of Staff from Washington

The departure of the Director of Ship Material staff, numbering about 200 personnel, by special train for the West Coast on 29 April, marked the end of the Washington phase of ship preparation work. From January through April, this work had been carried on by means of planning in Washington and execution of plans in Army and Navy field activities, principally naval shipyards. From now on planning would be closely integrated with the final preparations made on the target ships at Pearl Harbor and at Bikini. The tasks which lay ahead, apart from these last-minute preparations, would largely involve reorganization of the staff for operations in the target area, more preliminary inspections of the ships before the tests, rehearsal on Queen Day, and technical inspections subsequent to Able Day. After 6 May, when WHARTON got underway from Oakland for Pearl Harbor with the Director of Ship Material groups aboard, a program was started for training inspection personnel and for acquainting staff members with the general aspects of the Operation Plan. Studies were made of the component parts of the target ships as compared with more modern vessels, of the organization of the inspection groups, and of the nature of the technical reports which would be required.

Rear Echelon

When the Task Force was first formed it had been envisioned that there would be a definite need for close liaison between the staff at Bikini and the various Army and Navy parent organizations participating in the Task Force. To provide this liaison, a duplicate staff, designated as Task Force One Rear Echelon, with members representing each

of the nominal positions and groups included in the staff to be at Bikini, was to remain in Washington. Most of the members worked with the groups they were to represent during the preparatory phase and were entirely familiar with the operation. On 25 April, the Director of Ship Material held a conference with members of his Rear Echelon Group to outline the matters which would be handled in the rear area and to emphasize the importance of conscientious and expeditious progressing of all such matters. Comdr. W. W. Keller, who had been working with the Bureau of Ships Group, represented that Group and acted in the capacity of Director of Ship Material on the Rear Echelon staff. He was supported by Col. G. W. Trichel, who coordinated all phases under the Army Ground Group, Comdr. R. B. Heilig, who progressed matters under the cognizance of the Bureau of Ordnance, Comdr. J. K. Leydon, who acted for the Bureau of Aeronautics, and Lt. S. H. Seal, who assisted for the Bureau of Medicine and Surgery. Each of these officers had staff members under them in charge of particular phases of their work or representing special units. When the staff departed on 29 April for Bikini, the Rear Echelon staff took over duties concerned with Crossroads in the Washington area.

Stopover at Pearl Harbor

The movement of WHARTON has been synchronized with the movement of the target ships so that the major combatant ships prepared on the West Coast, as well as auxiliaries, destroyers, landing craft and submarines, would be at Pearl Harbor while the staff of the Director of Ship Material was there. Many of the target ships, including all the major ones, were available during the period 12-22 May when WHARTON was berthed at Pearl Harbor. Commanding officers of target ships met with staff members in conferences, and acquaintance inspections of the ships were made. Personnel of the advance Crossroads units completed the last-minute work of the preparatory phase before moving aboard WHARTON to merge with the regular staff. This made an end to the

naval shipyard phase of ship preparation work, and on 22 May, WHARTON left Pearl Harbor enroute to Bikini Atoll.

Final Preparations at Bikini

It had been planned that the target ships, with the special materials and instruments mounted on them, would be ready for the tests upon their arrival at Bikini. When WHARTON anchored in Bikini Lagoon on 29 May, the principal work which remained was the checking off, by various groups, the detailed completion of the work done by the ships' forces for final preparation. There were some additional preparation tasks such as the installation of delicate instruments, which it had not been practical to mount beforehand, and the completion of the pre-test photographic record. The Army Ground Group, apart from checking its exposed materials, arranged special displays of fuel samples, quartermaster stores, and field equipment. The Bureau of Ships Group sent out pre-test inspection teams which, while checking target ships for readiness of hull, machinery, and electrical equipment, were indoctrinated for post-test inspections. The Bureau of Aeronautics Group checked the operational readiness of aircraft on the two carriers, the static exposure of aircraft on other target ships, and the displays of aeronautical material. The Bureau of Ordnance Group mounted mines, metallurgical samples, and special ammunition on various target ships, as well as checking the operational readiness of all ordnance equipment. The instrumentation unit under Comdr. R. M. Langer, concerned with both technical photography and ships instrumentation, set up icaroscopes on observer ships, special instruments in target ships, and aerological and spectroscopic installations ashore.

Rehearsals of Initial Boarding Teams

On 15 and 19 June, the Director of Ship Material held re-

hearsals for the Initial Boarding Teams, which were realistic in detail, just as they would occur during the actual operation, except that the Lagoon was not evacuated. The Director of Ship Material stated in his situation report after the first rehearsal that it was generally satisfactory except for failures in communications between WHARTON and MOUNT MCKINLEY, HAVEN, CUMBERLAND SOUND, and his observer in PBM Charlie; and at the same time he commented that the greatest bottleneck in reboarding operations would likely come from the drone boats used for radiological reconnaissance. Communications were slightly better during the second rehearsal, and a communications drill was held on 20 June to smooth out the weaknesses which remained. Meanwhile, the Army Air Forces had been conducting independent drills with bombing runs on NEVADA. Their inability to distinguish this ship from high altitudes resulted in the decision to paint the upper surfaces of its topside structure white and to install a radio-controlled searchlight for guiding the B-29 on its bombing run. After making these preparations, the Director of Ship Material organization was ready for the full dress rehearsal on Queen Day.

Situation Reports to Deputy Commander

The results of these rehearsals were included in the situation reports, which the Director of Ship Material has been dispatching to the Deputy Task Force Commander for Technical Direction regularly, three times a week, beginning with the first report on 21 May, just before departure of WHARTON from Pearl Harbor. On 29 May, the day of WHARTON's arrival at Bikini, the Director of Ship Material reported the results of his conference with the Technical Director relative to interference between exposure of special ammunition and the location of instruments on some of the auxiliaries. These reports gave a running summary of the last-minute work of ship preparation as well as information on operational plans for Able Day. The Director of Ship Material reported on 11 June that the plan for the Initial Boarding Teams had been

distributed.¹ Subsequent reports contained information and criticism of the various rehearsals which either had been held or were being planned

Postponement of Queen Day

Early in June, the Commander Joint Task Force One had tentatively designated 25 June as Queen Day, which would include a full dress rehearsal for Test Able with evacuation of the Lagoon and the dropping of a light bomb, weather permitting. By mid-June, prevailing weather conditions indicated the advisability of an earlier designation for Queen Day, so that there would be greater leeway for Test Able in the event of bad weather and a necessary postponement of Queen Day. On the morning of 22 June, MOUNT MCKINLEY, the flagship, signalled the Task Force that the following day would be Queen Day. Immediate evacuation of the target ships commenced according to plan, and at noon the Initial Boarding Teams took **their stations, with the Director of Ship Material** embarked in RECLAIMER. Captain Forest, technical observer for the Director of Ship Material, had gone to Kwajalein the previous evening in preparation for the rehearsal post-test flight in PBM Charlie. Shortly after midday, the non-target ships began evacuating the Lagoon, and by sunset all ships were in their prescribed sectors outside the atoll. Around midnight, the Commander Joint Task Force One stated that the weather forecast for 23 June indicated that Queen Day would have to be postponed, and he directed that the six ships carrying participating observers anchor inside the entrance of the Lagoon as soon as possible after dawn. These ships remained at anchor until late afternoon on 23 June, when they again proceeded to the assigned operational sectors.

¹See Annex X, Appendix X: Initial Boarding Teams.

Queen Day Rehearsal

At 0800 on 24 June, the Commander Joint Task Force One confirmed that day for Queen Day and set 0835 as the official time for the bomb drop. After the B-29 had dropped its 500-pound phosphorus fragmentation bomb, all units of the non-target ships commenced re-entry operations, simulating as closely as possible the conditions which would exist on Able Day. At 1000, Captain Forest, who was in PBM Charlie, started sending simulated reports on damage; and the Deputy Director of Ship Material, functioning as Target Control Officer on WHARTON, began plotting the condition in the Lagoon. Around 1300, the initial boarding teams entered the Lagoon and began their inspections of target ships. Late in the afternoon, after thirty-eight ships had been inspected by these teams, the Deputy Director of Ship Material directed target ships teams to return to each of fifty six ships; and the remainder of the crews of the target ships boarded, as well as the crews of those not boarded, returned the following morning. In his situation report on the day after the rehearsal, the Director of Ship Material expressed general satisfaction, but pointed out that communications between WHARTON, MOUNT MCKINLEY, and PBM Charlie were poor, and that the radiological reconnaissance, as predicted, was slow.

OPERATIONS DURING TEST ABLE

Evacuation of Lagoon

Weather forecasts on 30 June indicated that the day selected for Able Day, 1 July, would be satisfactory for the bomb drop; and at 0900, the morning of 30 June, the signal was sent from MOUNT MCKINLEY designating the following day as Able Day and setting in motion the Evacuation Plan.¹ Target ships' crews immediately began placing the target ships in the condition of readiness that had been established for these ships for Able Day, and then left them for the APA's which were to serve as their quarters throughout the test period. Certain instrumentation teams made final checks of instruments before returning to their ships. The Director of Ship Material, together with Team No. 6, went aboard RECLAIMER and the other nine Teams boarded the ships assigned them by the Initial Boarding Team Plan.² In the early afternoon, the non-target ships started leaving the Lagoon; first, the destroyer patrols and boarding team ships, followed next by the ships of the Instrumentation Unit and repair ships, and last, the quarters transports. All vessels proceeded to special sectors outside the Lagoon where they steamed throughout the night awaiting Able Day.

Dispersal of Staff

Once the Evacuation Plan had been set in motion, the staff of the Director of Ship Material became temporarily dispersed. Most of the officers of the staff in WHARTON were on Initial Boarding Teams, each team having a representa-

¹See Annex H: Bikini Evacuation Plan

²See Annex X, App. X: Initial Boarding Teams

tive and two assistant representatives of the Director of Ship Material, an ammunition safety officer, and members from the Radiological Safety Section and the Damage Control Safety Section in HAVEN. Officers filling these assignments had been drawn from all the Bureau groups, so that this part of the staff, together with the Director of Ship Material, took station in the ten small ships provided for the Initial Boarding Teams, which steamed east of the Lagoon during preliminary part of the Able Day operations. Members of the Electronics Group remained in AVERY ISLAND, and unassigned members of the Bureau of Medicine and Surgery Radiological Safety and Damage Control Safety Section remained in HAVEN, both of which steamed with WHARTON and other ships of the Instrumentation Unit in a sector northeast of the Lagoon. The Deputy Director of Ship Material, the Army Ground Group, and other personnel not assigned to teams but attached to the staff, remained in WHARTON. Officers attached to the staff, remained in WHARTON. Officers attached to the Target Inspection Unit were assigned to the Deputy Director of Ship Material to assist him in his function as Target Control Officer during the Test Able operations. All other staff officers remaining in WHARTON, together with the civilian observers, were assigned to reserve teams which could be called upon to assist the Initial Boarding Teams as might be necessary in post-bombing phases of the Able Day operation.

Dropping of Bomb

Forecasts for Bikini weather on 1 July proved to be excellent, and Able Day dawned sunny, bright and clear. The B-29 Army plane carrying the atomic bomb took off from ~~Marjalein~~ at 0553, destined to be over the target at the designated bombing time of 0830. The aerial observer for the Director of Ship Material took off from Ebeye in PBM Charlie about the same time to be in the vicinity of Bikini Lagoon following the ~~blast~~ detonation. As the time for the bomb drop drew near, an air of excitement spread through the Initial

Boarding Teams in their ships east of the Lagoon and the observers in the ships of the Instrumentation Unit northeast of the Lagoon, who were about to witness the first explosion of an atomic bomb over water. All these observers were kept informed of the progress of events through ships' address systems relaying information received from MOUNT MCKINLEY via radio. A few minutes after 0800, the announcement came that there would be a delay of approximately twenty minutes in the bombing, as the bombing plane would have to make a second run on the target. At 0845, it was announced that the plane was on the bombing run and the bomb would fall in fifteen minutes. All observers who had been supplied with special dark goggles were instructed to turn away from the direction of the Lagoon and cover their eyes with their arms; those with goggles were permitted to look directly at the bomb detonation. At exactly 0900, the report "bombs away" reached the Task Force, and after several seconds the brilliant explosion of the bomb sent a feeling of relief over the observers as they watched the atomic cloud spiral into the air, the climax to many months of preparatory work.

Aerial Reports from PBM Charlie

As the wind on Able Day was considerably less than usual, the atomic cloud which had spiralled up to about 35,000 feet did not disperse rapidly. While the cloud particles drifted slowly to the southwest, the air directly above the target array remained highly radioactive. This meant that PBM Charlie was not able to fly over the Lagoon for a considerable time after the bomb explosion. The first report from this observer came at about 1000, after PBM Charlie had been able to circle the outer fringes of the Lagoon to permit a rather long distance observation. In this report, the observer stated that both GILLIAM and CARLISLE had sunk, that LAMSON was on its side and sinking, and that SAKAWA appeared heavily damaged: all of these observations implied that the detonation point had been considerably astern of NEVADA, the tar-

get bull's eye. This was the first word picture that observers outside the Lagoon obtained. From that time on until late afternoon, the aerial observer continued to circle the Lagoon and to fly directly over the target array as the radioactivity of the air decreased. Throughout this period numerous reports were made on conditions within the Lagoon as seen from the air, including such matters as the fires which appeared on numerous ships. Besides the Director of Ship Material, to whom they were of most immediate interest, the reports were received by Commander Joint Task Force One in MOUNT MCKINLEY, Commander of the Target Group in FALL RIVER, and the Deputy Director of Ship Material in WHARTON, all of whom required the reports in the operation functions.

Re-entry into Lagoon

Immediately following the explosion the waves of ships outside the Lagoon proceed to new stations preparatory to the re-entry prescribed by the Re-entry Plan.¹ This plan, which had operated successfully on Queen Day, was followed without change. By mid-day, while the drone boats were sweeping the array, FALL RIVER and MOUNT MCKINLEY had taken station near the entrance to the Lagoon. Shortly after noon, the first of the Initial Boarding Team ships entered the Lagoon and inspection of the ships in the outer part of the array began. The Director of Ship Material in RECLAIMER personally directed fighting of fires on NEVADA, SARATOGA, NEW YORK and PENNSYLVANIA, all of which were localized fires started in exposed Army quartermaster equipment. While the Initial Boarding Teams were proceeding with these preliminary inspections, the Deputy Director of Ship Material in WHARTON maintained an up-to-the-minute plot of radiological clearance and inspection progress. He was in direct radio communication with the Director of Ship Material and all Teams, as well as with Commander Joint Task Force One

¹See Annex I: Re-entry Plan.

and the Radiological Safety Officer. On his plot he was able to show, through the frequent reports, a "Red Line" which indicated the line of advance of the radiological monitors behind which the water had been inspected, and a "Blue Line" which indicated the line of advance of areas that had been cleared as radiologically safe. By 1500, the "Blue Line" had passed through most of the target array, and the Lagoon was considered safe for the return of the ships of the Instrumentation Unit. These ships, which had been steaming close to the entrance, entered the Lagoon at that time and anchored northeast of the array for the night.

Preliminary Survey of Damage

As the ships of the Instrumentation Unit took station within the Lagoon, the Deputy Director of Ship Material and his observers in WHARTON were able to get their first visual observation of the extent of the damage created by the air blast. It was quite apparent from even such cursory examination that the center of the blast was some distance astern of NEVADA and that the easily discernible structural damage was confined to a circle of fairly definite radius from this center. Considerable topside structural damage could be noted on ARKANSAS, NEVADA, PENSACOLA, SALT LAKE CITY, CRITTENDEN, RHIND, and HUGHES, and very extensive damage was evident on SKATE, INDEPENDENCE, and SAKAWA. Minor damage was obvious on other ships. It also noted that the destroyer ANDERSON had disappeared from view, a fact not previously reported. The few ships which were officially cleared for radiological safety were all among those outside of the apparent circle of damage. It was thus decided that no inspection teams would be sent aboard to survey the damage until the Director of Ship Material and his Deputy had had an opportunity to confer with their representatives on the Initial Boarding Teams.

Able Day Situation Reports

The first report on damage to the target array was submitted to Commander Joint Task Force One by the Deputy Director of Ship Material in the evening of Able Day. This report was a brief summation of the observed damage as garnered from the radio reports of PBM Charlie, the Initial Boarding Teams, the Director of Ship Material, and the verbal reports of the observers on WHARTON. The Director of Ship Material reported in person to the Commander Joint Task Force One that same evening and described his findings in the presence of the Secretary of the Navy. Following this conference, members of the press interviewed the Director of Ship Material to obtain an account of his findings for publication. Since the Initial Boarding Teams had not completed their work, the Director of Ship Material returned to WHARTON and recalled the head of these teams for conference to plan the next phase of their operation. At this time each team was directed to make a full report of its findings as soon as it had completed its assignment. The teams completed operations the following day and by evening of Able Day plus one submitted their reports, from which, together with the full report of his aerial observer, the Director of Ship Material immediately prepared and submitted his Preliminary Damage Report. Able Day operations were necessarily hazardous as were Queen Day operations and it is a commentary on the excellent training and supervision that no casualties or injuries had to be reported.

Reboarding of Target Ships

Early on the morning of 2 July, the heads of the Initial Boarding Teams returned to their respective team ships and

with their teams continued the preliminary survey and clearance of target ships. SAKAWA was down by the stern, and the Director of Ship Material directed that the salvage group endeavor to beach this ship. During operations incident to this effort, SAKAWA took on much more water and sank. Another team was able to approach INDEPENDENCE, extinguish remaining fires, and go aboard, as could not be done the previous day because a heavy fire in the stern near some ammunition made any approach too dangerous. But radiological monitor readings showed that INDEPENDENCE was above the allowable tolerance in radioactivity and could not be cleared for immediate boarding of technical inspection groups. CRITTENDEN, ARKANSAS, NEVADA, YO-160, and SKATE were also found to be above the tolerance in radioactivity. By early afternoon, fifty-six other ships had been cleared, as well as miscellaneous small craft, and the Deputy Director of Ship Material ordered the return of target ships' crews to these ships from their quarters transports. He also permitted instrumentation teams to visit several of the cleared ships to check instruments, and the Naval Medical Research Section to withdraw animals. By evening, commanding officers of twenty-three target ships had reported their ships clear and ready for technical inspection.

Control of Inspections

The original inspection plan intended that the technical inspection teams be large composite units, including members from all groups, each of which could make a complete examination of a ship. But the variation in degree of damage to materials under the cognizance of the different groups indicated that the use of small teams composed of members from only one group or unit, with coordinated operation of the small teams, would expedite the inspections. For example, on INDEPENDENCE, where topside damage was severe, representatives of the hull unit, Bureau of Ships Group, made inspections and analytical studies during almost the entire period between tests, whereas the machinery and electrical units, as well as

most units of the Bureau of Ordnance Group, were able to complete their inspections in a few days. Again, on SARATOGA, where damage was slight, most Groups were able to complete an examination in a few hours, but the Army Quartermaster unit required two days to inspect, record, and photograph the damage done to exposed materials. The plan of inspection by small unit teams permitted each team to conduct its phase of inspection on a ship without delay to or from any other group of inspectors. The task of coordinating the operations of the numerous teams fell to the Target Inspection Officer who was charged with both providing transportation for the inspecting groups and also with keeping records of inspection progress. To accomplish this task, this Officer required each Group to submit each evening an inspection list indicating the number of unit teams to be sent out and the ships to be visited the following day. From the combined lists of all Groups he established a schedule order for transporting the teams to the ships to be inspected. Each Group also submitted to the same officer each evening a summary of the inspections completed by its units during that day. From these summaries the Target Inspection Officer issued to the Director of Ship Material a daily inspection progress report which formed the basis of the highlight Situation Report¹ sent to the Deputy Commander Joint Task Force One for Technical Direction.

Repair and Salvage Work

Although the technical inspections progressed rapidly, there could not be a full assessment of the damage done by the air blast without examination of the sunken ships nor without checking the operation of the functional equipment on these ships which had been deprived of boiler power. The Salvage Group, therefore, set to the task of conducting diving

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¹See this Chapter: PREPARATIONS FOR THE TESTS;
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operations on the sunken ships and on 7 July, one diving team made a preliminary examination of GILLIAM. Shortly thereafter, other diving teams were able to examine and photograph both ANDERSON and CARLISLE, and later LAMSON. Diving operations proceeded rather slowly due to time limit imposed on the divers by the depth of the water, some radioactivity in the region of the sunken ships, and the disturbance to divers by ship movements within the array; but by 14 July, inspections of GILLIAM and CARLISLE were complete and only a few more photographs of ANDERSON was needed. After a preliminary examination of boilers, stacks and uptakes in the six ships which had no power, the Director of Ship Material decided that at least one boiler in each of these ships could be placed in commission in a reasonably short time. On 3 July, he directed the affected ships to make this repair and requested Service Division 11 to progress the task. Ships' crews assisted by personnel of the Service Division and boiler technicians of the Bureau of Ships Group, accelerated the work which was completed on 12 July when a boiler was lighted off in INDEPENDENCE. SKATE, although severely damaged topside, was able to move alongside a repair ship under its own power on 8 July where a full technical inspection was made and the topside structure was partially repaired for her exposure in Test Baker.

Damage Reports

Prior to departure from Washington, the Director of Ship Material had agreed to submit two reports after each test to the Deputy Commander for Technical Direction: the first, a summary of the damage assessed by technical inspection groups in their first inspection of the ships, to be submitted five days after the test; the second, a similar but more comprehensive summary based upon detailed studies of the damage by the inspection groups, to be submitted approximately twenty days after the test. The first of these reports after

Test Able, was given to the Deputy Commander on 6 July. In addition, the Director of Ship Material resumed, on 2 July, his situation reports to the Deputy Commander which highlighted the progress of all activities under the Director of Ship Material. As Test Able inspections and Test Baker preparations neared completion, all groups turned full attention to the preparation of the second report, which was submitted to the Technical Review Board just prior to Baker Day. This detailed report was submitted to the Deputy Commander on 4 August. With submission of this report, the technical observers postponed study of the results of Test Able until preparation of the final report, to be done in Washington.

OPERATIONS DURING TEST BAKER

Re-arrangement of the Array

While the technical inspections were proceeding, arrangements went ahead for Test Baker, which was tentatively set for 25 July, and for the William Day rehearsal scheduled for 19 July. The error of bombing on Able Day, which had caused sinkings and damage not anticipated, forced reconsideration of the target array for Test Baker. On 6 July, the Director of Ship Material joined in conference with the Task Force Commander, Deputy Commanders, and members of the Joint Chiefs of Staff Evaluation Board to discuss recommendations for changes in the array.¹ The principal modifications involved substitution of alternate ships for those which had been sunk, interchange of certain ships to place those damaged by Test Able in less lethal positions, and slight changes of certain other ships in range and bearing from the burst center to provide better graduation of distance and thus better graduation of anticipated damage.² Meanwhile, Commander Task Group 1.2 executed the re-positioning of those ships not involved in the discussion of substitution or interchange, and completed the re-arrangement when the final array was approved.

Ship Mooring

When the ships were first re-positioned for the Test Baker array, only ARKANSAS and SARATOGA were moored bow and stern to maintain their position, relative to LSM-60, the bomb carrying ship. On 10 July, the decision was made to insure positioning of other large ships which would be rea-

^{1,2}See this Chapter: DEVELOPMENT OF THE TARGET ARRAY: Changes Resulting from Test Able.

sonably close to the burst center and NEW YORK, NA^C PENSACOLA, and SALT LAKE CITY were similarly n. bow and stern. All other ships in the array, except the submarines, anchored with two anchors, one with chain in normal straight run, the other with chain looped up in bights to hold the ship in case the first chain parted.¹ Mooring six unmanned submarines in submerged positions was a complex task which could not be accomplished until just prior to the Baker Test. This operation involved surface controlled trim dives of anchored submarines to a depth where weights hanging from the craft rested on the bottom and reduced the downward drag. Although the Salvage Group, assisted by members of the Submarine Unit, who had devised the submergence procedure, started the task on 21 July, two of the submarines surfaced and had to be re-submerged, delaying completion until early morning of Baker Day. The remaining two submarines of the group were moored in surface berths.

Ship Preparation

Directives on ship preparation were for the most part applicable to both tests, and during the middle of July, the technical inspection teams, while continuing to assess the results of Test Able, commenced to check off readiness of the ships for Test Baker. Ships' forces, duplicating the work done for Test Able, recorded the necessary information for pre-test inspection forms and readied machinery and equipment as required. Operation of machinery and other functional equipment on ships changing position in the array under their own power served not only to check results of Test Able but also to indicate condition of this equipment prior to Test Baker. Much of the material, which had been exposed topside for the air burst, had been removed and shipped to continental United States for analysis; and exposure plans for the

¹See Chapter 2: PREPARATION OF TARGET SHIPS; General Preparations.

underwater burst did not entail its renewal or replacement, especially that belonging to the Army Ground Group. Units of the various groups under the Director of Ship Material checked special test materials under their cognizance and the readiness of equipment that was to be energized. The Instrumentation Groups inter-changed and re-located numerous instruments to measure the phenomena anticipated in Test Baker.

William Day Rehearsal

On 16 July, the Director of Ship Material reported to the Deputy Commander that preparations for Test Baker were about ninety percent complete and that all essential items of preparation could be finished before Baker Day. Thus there appeared no reason to extend the schedule, and at 0900, 18 July, Commander Joint Task Force One signalled that the following day would be William Day. Except for slight last-minute modifications which permitted a few personnel with special tasks to remain on ships within the Lagoon, the Task Force carried out the Evacuation Plan.¹ Once again the Director of Ship Material embarked in RECLAIMER, with modified Initial Boarding Teams in other ships of the Salvage Group. Captain Forest and Commander Batcheller, who were to alternate as technical observers during the second test, went to Ebeye for the rehearsal flight in PBM Charlie.

Shortly before midnight, the Task Force Commander confirmed 19 July as William Day, with How Hour, the intended bombing time, set at 0835. Weather conditions over the Lagoon the next morning were slightly less favorable than desired, necessitating cancellation of the Drone Flights, and How Hour was postponed to 0905, at which time a dummy bomb was detonated on the firing barge. This simulated atomic bomb explosion activated the Re-entry Plan, and units of the non-target fleet, led by ships of the Salvage Group, commenced the approach to the Lagoon. Since the Ini-

¹See Annex H, Add. I: Bikini Evacuation Plan.

tial Boarding Teams conducted only a simulated drill and did not board any vessels, this phase of the re-entry proceeded rapidly. All of the transports had anchored within the Lagoon by late afternoon, and the ships' teams returned to their respective ships. The Director of Ship Material's situation report, after William Day, pointed out that poor communications between WHARTON and MOUNT MCKINLEY during the first hour after re-entry was the only difficulty marring an otherwise satisfactory rehearsal.

Changes in Boarding Procedures

Anticipating that contamination of the Lagoon and the target ships in Test Baker would delay re-entry, original re-boarding plans prescribed that Initial Boarding Team members would remain on their quarters transport ships and would be picked up by the Salvage ships as circumstances required. As the day of bombing neared, discussions with scientific advisors indicated that conditions within the Lagoon might permit some investigation of results within a few hours after detonation. This prompted the Director of Ship Material to revise Initial Boarding Plans with a view toward following a procedure similar to that used for Test Able; and for the William Day Rehearsal, Initial Boarding Teams, without Radiological Monitors and Damage Control Safety Officers, who remained in HAVEN, conducted a simulated drill, operating from the Salvage vessels in small boats. Revisions after the rehearsal eliminated the small boat procedure which involved picking up the monitors and safety officers from HAVEN. The final plan of 23 July listed completely new Initial Boarding Salvage vessels during Baker Day operations.

Baker Day

Although weather conditions on 24 July did not seem favor-

able, forecasts for the following day influenced Commander Joint Task Force One to signal, at 0900, that Baker Day would be 25 July with How Hour at 0835. Evacuation of the Lagoon, which commenced immediately, followed the pattern set during Able Day¹ and was finished when the Deputy Commander for Technical Direction and his assistants left LSM-60 at 0530 the following morning. Again the Director of Ship Material was in RECLAIMER with his staff temporarily dispersed among ships of the Salvage Group and Instrumentation Unit² which steamed in sectors northeast of the Lagoon throughout the night. Early on 25 July, when weather forecasts appeared to be correct, Commander Joint Task Force One dispatched confirmation of Baker Day and How Hour to the Task Force and other interested parties. As time neared for the detonation, the observers, in non-target ships steaming a few miles outside the Lagoon, were kept informed of developments by time broadcasts from CUMBERLAND SOUND; and personnel gathered topsides on the the various ships were instructed that protective goggles would not be needed to view this burst. At exactly 0835, a large column of water erupted from the center of the array, coincident with the final time announcement of bomb detonation. This tremendous mass of water, rising into the air to a height of nearly 3000 feet fell immediately over the array, leaving a cloud of mist and steam which hovered above the array for several minutes and obstructed view of all but a few ships on the outer periphery.

Reports of Technical Observer

About fifteen minutes after the detonation, the cloud began to clear and the familiar outlines of some of the larger ships in the array could be seen by observers outside the Lagoon. However, the fact that sinkings had occurred could not be

^{1,2}See this Chapter: OPERATIONS DURING ABLE DAY:
Evacuation of the Lagoon.

established until the first report from the aerial technical observer, at 0907, stated that ARKANSAS and three LCT's were not in sight. Reports following closely thereafter indicated that SARATOGA was down by the stern and listing slightly to starboard with her stack collapsed on the flight deck, that no fires were visible on ships or on the water, that YO-160 had sunk, and that one LCT previously reported missing was alongside LST 133. A summary sent at 0950 indicated another missing LCT was located. Shortly after 1000, reduced radioactivity in the air mass above the array permitted PBM Charlie to move down from 4000 to 3000 feet. Closer observation of SARATOGA determined that she definitely was sinking, and at 1130, the observer recommended that every possible effort be made to beach her. Later reports noted NEW YORK down by stern, FALLON listed to starboard, and an object alongside ARDC-13 tentatively identified as an LCT. At 1300, Commander Batcheller, in a second PBM Charlie, took station over the Lagoon, relieving Captain Forest as technical observer. Continued observations throughout the afternoon included reports that HUGHES had settled about four feet and listed slightly to port and that position of buoys indicated four submarines were on the bottom. Another message confirmed the object alongside ARDC-13 to be the third missing LCT capsized.

Re-entry into Lagoon

The Re-entry Plan¹ was set in motion immediately following the detonation. Within an hour, Commander Joint Task Force One directed Radiological Patrols to enter the Lagoon, FALL RIVER to take stations as Harbor Entrance Control, and KENNETH WHITING to anchor inside the Lagoon to permit technical personnel to recover instruments and cameras from Bikini and Enyu Atolls. Following the drone boats, which had started radiological patrols throughout the array, the Director

¹See Annex I: Re-entry Plan.

of Ship Material and Initial Boarding Teams, in ships of the Salvage Unit, entered the Lagoon at 1105. In the following two hours, boarding teams examined and cleared a number of ships on the outer edge of the array within the small area declared radiologically safe. These ships included NIAGARA, BLADEN, CORTLAND, FILLMORE, GENEVA, and a few small landing craft, all of which had escaped the heavy down-pour of contaminated water resulting from the eruption. Meanwhile, ships of the Instrumentation Unit were approaching the Lagoon and shortly after 1400 anchored a few hundred yards inside the entrance. Unlike after Test Able, the observers on the latter ships could note no particular damage other than that described by the aerial observer. SARATOGA had continued to sink but radiological hazards prevented any salvage operations and at 1609 her flight deck settled out of sight. Attempts by the Director of Ship Material to investigate and conduct necessary salvage operations on FALLON and HUGHES were likewise thwarted by the radiological hazards involved, and ships other than those previously mentioned could not be examined. Progressive reports to the Deputy Director of Ship Material in WHARTON, maintaining a radiological plot of conditions within Lagoon as Target Control Officer, implied a long delay in advance of the "Blue Line"¹; consequently, eight Initial Boarding Teams with radiological monitors returned to WHARTON that evening to await further developments. The Director of Ship Material and the other two Initial Boarding Teams remained with the Salvage Unit throughout the night.

Preliminary Salvage Operations

For several days, drone boat radiological reconnaissance of the water in the Lagoon continued to show a high degree of contamination, creating considerable difficulty in re-boarding

¹See this Chapter: OPERATIONS DURING TEST ABLE:
Re-entry into Lagoon.

and salvage attempts. Late in the afternoon of 26 July, RECLAIMER, with Director of Ship Material supervising, succeeded in taking HUGHES in tow and beaching her on Enyu Island, but PRESERVER, making similar efforts on FALLON, failed, due to the intense radiation. On the 27th, contamination in the area north of the array subsided to a degree permitting ships of the Instrumentation Unit to move to their permanent berths. This same day, TUNA and DENTUDA were surfaced by the Salvage Unit, which also successfully beached FALLON. While these operations were being conducted, instruments and animals were removed from those ships previously reboarded and from a few additional auxiliaries. On 29 July, the Director of Ship Material advised the Task Force Commander that radiological hazards prevented salvage operations on NAGATO, which showed progressive flooding, and that he intended to concentrate decontamination efforts on PENSACOLA, NEW YORK, and other damaged ships which would in time require salvage measures. Late that night, NAGATO, which had not been reboarded, sank.

Decontamination Measures

Improvement in the radiological condition of the water warranted discontinuance of drone boat reconnaissance on 30 July, but intense radioactivity persisting in the target ships prohibited inspection on a major scale and discouraged prospects of early reboarding. Endeavoring to devise a means of diminishing this radioactivity, the Director of Ship Material and his staff immediately began vigorous experimentation. The seriousness of this problem prompted promulgation of a memorandum on decontamination,¹ which stated the factors involved in clearance of contaminated ships, outlined proposed procedures for decontamination, and reviewed in detail the safety instructions for protection of personnel. Decontamination was to proceed in two phases: a preliminary

¹See DSM Memorandum #13 of 31 July 1946.

treatment consisting of washing down entire ships to remove the less firmly attached fission products and increase the tolerance period for boarding; then a second more drastic operation consisting of scrubbing and scraping topside surfaces and removal of the porous materials with high affinity for radioactive matter. Staff members working with the Salvage Unit from the salvage ships conducted the preliminary treatment and special ships' crew teams carried out the subsequent process during short periods on board. Single washings with various solution followed by plain water proved partially successful but several washings were necessary to improve conditions sufficiently to insure safe reboarding.

Technical Inspections

Only the five APA's originally reboarded were fully manned and in normal operation by 1 August. However, concentrated decontamination began to show improvement, and after several days, representatives of the Director of Ship Material were able to inspect additional ships. By 5 August, crews had pumped flooded machinery spaces of SALT LAKE CITY and PENSACOLA, and the special teams were carrying out secondary decontamination on these ships plus PRINZ EUGEN, NEW YORK, PENNSYLVANIA, NEVADA, four destroyers, one auxiliary, and one submarine. The following day, the Deputy Commander for Technical Direction emphasized that decontamination should be directed toward recovery of instruments and clearance of those ships which were designated for use in Test Charlie. Although the priority of instrument recovery delayed technical inspections, available staff members conducted examinations of the target ships as radiological conditions permitted. The limited availability of target ships, both in number and tolerance times, occasioned inspectors to work in large groups to provide maximum coverage of each cleared ship during the short period allowed on board. Pumping operations were required on GASCONADE, BRISCOE, MAYRANT, and a few others. Inspection teams followed up on the ships cleared each day by improved de-

contamination processes, and on 13 August, the Director of Ship Material, who on this date had assumed duties as senior member of the Technical Staff at Bikini, reported staff inspections completed on four auxiliaries, five destroyers, and seventeen landing craft in addition to the five auxiliaries first inspected. Other ships were clear but the extent of damage on these ships necessitated repeat inspections and prolonged completion until 22 August, at which time only FALLON had not been inspected.

Safety Program

The existence of radiological hazards throughout the entire period of Test Baker operations made mandatory the constant employment of safety advisors. In each individual operation, whether it be decontamination, salvage or inspection, a safety officer and a radiological monitor accompanied staff members and crews to check tolerances and insure adherence to safety instructions. The task of monitoring also included daily examination, by instruments, of clothing worn by personnel, who had been in contaminated areas, to prevent the spread of radioactive matter. Service of the numerous radiological instruments used by monitors became a serious problem, but this was solved by the Electronics Group, under the Director of Ship Material, which established a special section for repair and maintenance and successfully kept all instruments in service. The extension of the perfect record of safety again attested to the supervision, training and cooperation of all groups in the safety program.

Departure from Bikini

On 24 August, pumping and salvage operations refloated FALLON which was moved to a position in the target array for inspection. All other target ships had been inspected. As these inspections did not include operation of machinery due

to possible radiological dangers to personnel, some of the ships were moved to Kwajalein for later examination. When inspection of FALLON was finished on the morning of 25 August, the Director of Ship Material felt that all significant information had been recorded and reported that the technical inspection phase at Bikini was complete. Later the same day, the Director of Ship Material and the remaining members of his staff in WHARTON, accompanied by the Radiological Safety Group in HAVEN, departed from Bikini for Kwajalein to establish facilities there for continued examination and radiological re-checks of the target ships.

Damage Reports

By earlier agreement,¹ the Director of Ship Material was to submit the first damage report five days after the test. However, the inspection difficulties following Test Baker prevented meeting this schedule. The situation reports sent to the Deputy Commander three times a week relayed all the significant information on damage observed during the first week after the test. When a majority of the inspections were complete about 20 August, all groups began to concentrate on the preparation of the second damage report. This report was rushed to completion during the final few days at Bikini and Kwajalein and was sent to the Deputy Commander by air courier on 27 August. The submission of this report termina-

¹ See this Chapter: OPERATIONS DURING TEST ABLE: Damage Reports.

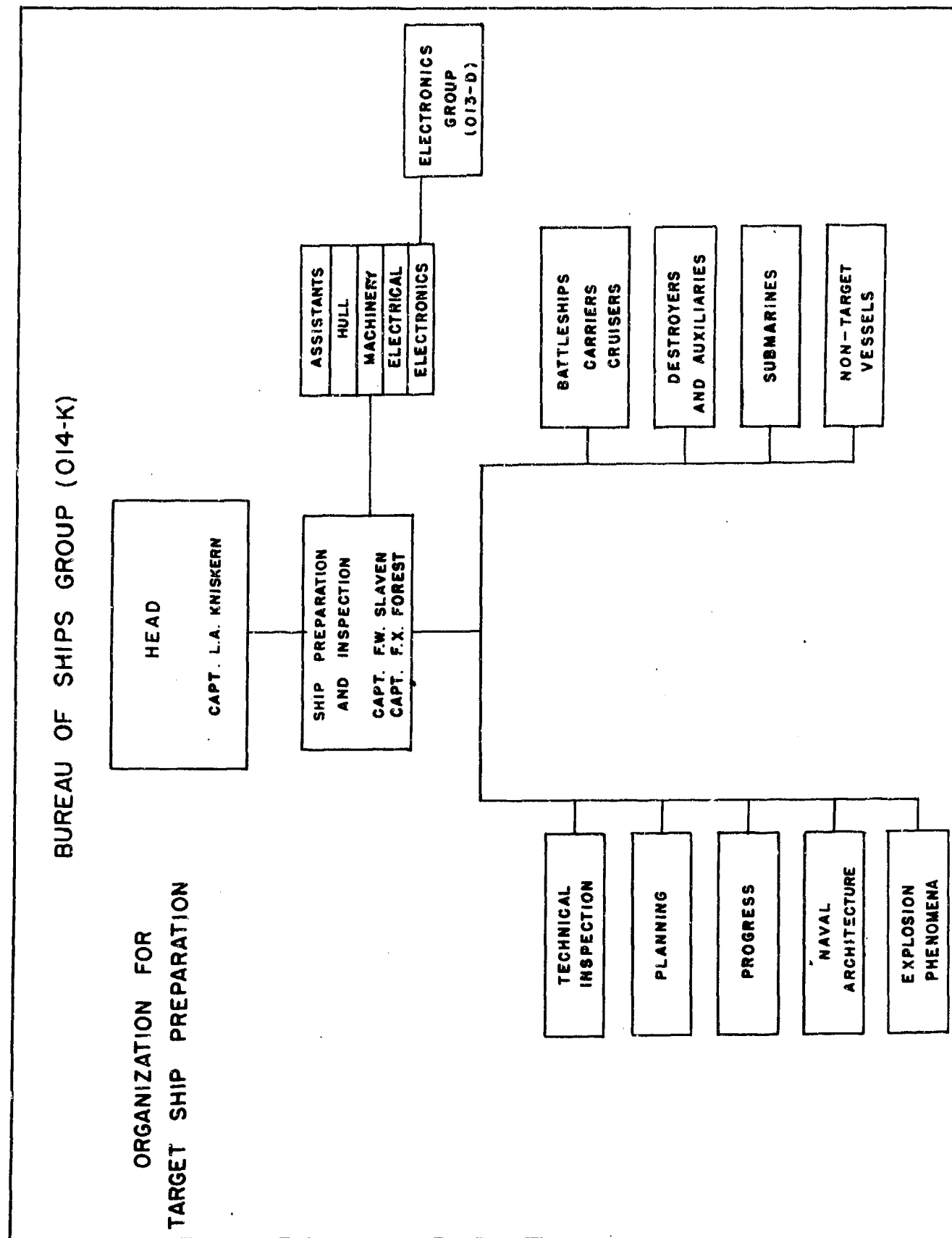
ted the activities of the Director of Ship Material in the Bikini Area. When facilities had been established at Kwajalein for future investigations of the target ships, the technical staff in WHARTON departed Kwajalein on 28 August. Upon arrival at San Francisco on 7 September, the technical staff departed for Washington, D.C., to resume further studies and analyses of the results of both tests and to prepare the final reports.

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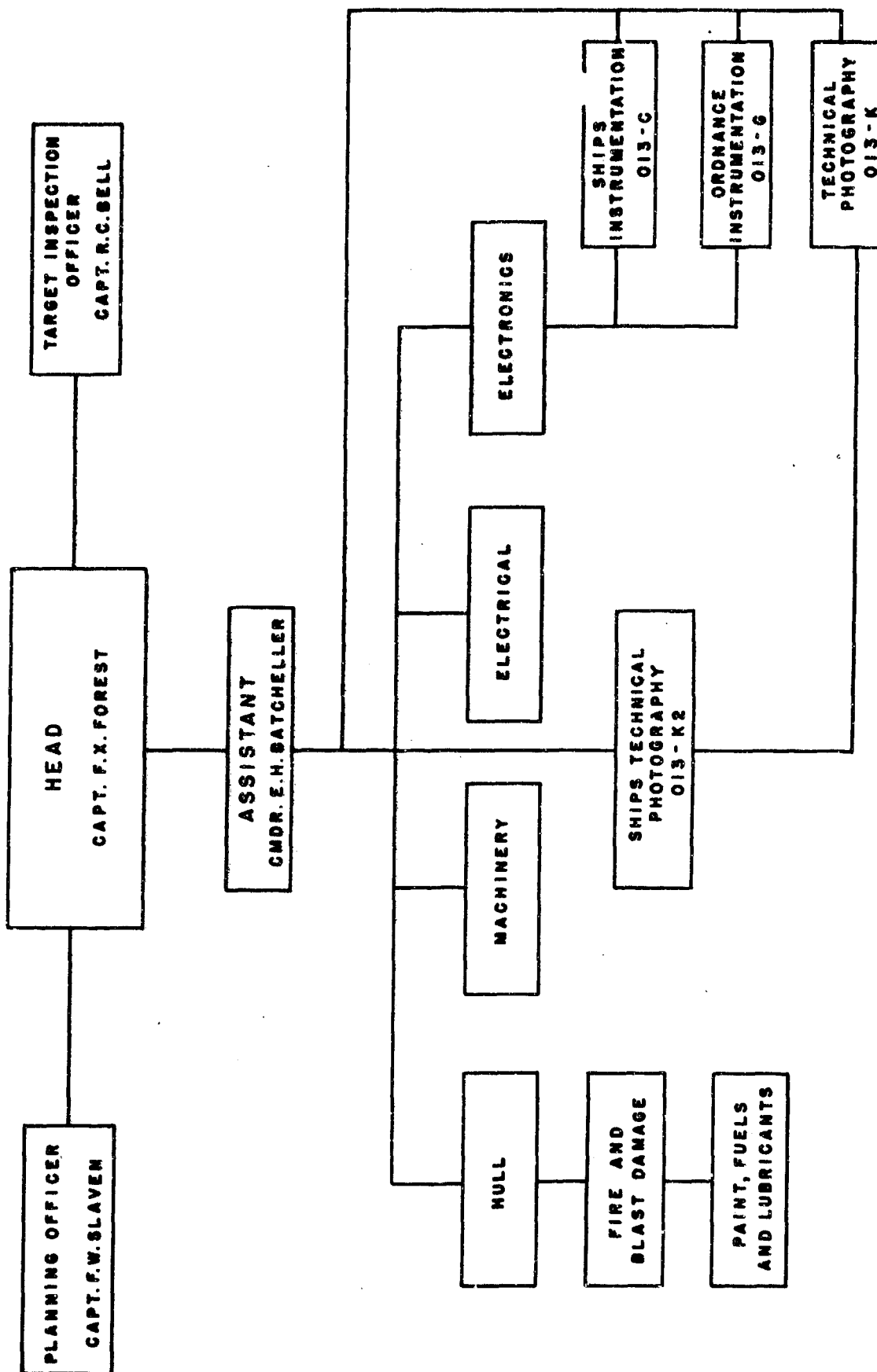
The entire foregoing chapter has been devoted to the activities of the Director of Ship Material from his assignment to Task Force One through the Test Operations to his final task of preparation of the reports. It has been endeavored in this chapter to record the chronological history of the Director of Ship Material with relation to the groups forming his staff and to other units of the Task Force. The activities of these groups and units are described in greater detail in the chapters that follow. An appendix is included to show pictorially some of these groups and the events about which this account is written.

CHAPTER 2

BUREAU OF SHIPS GROUP



BUREAU OF SHIPS GROUP (014-K)



BUREAU OF SHIPS GROUP

Formation of Group

The Bureau of Ships Group was officially activated by the Bureau of Ships on 23 January. Rear Admiral T. A. Solberg was placed in charge of all activities of the Bureau of Ships relative to Operation Crossroads. His subsequent assignment to the Task Force as Director of Ship Material required that, in practice, the Bureau of Ships Group act as his executive agency, under the direction of Capt. L. A. Kniskern, so that the Director of Ship Material would be able to carry out his responsibilities under the Deputy Task Force Commander for Technical Direction. The Bureau of Ships Group, with Captain Kniskern as head, worked directly under the Director of Ship Material.

The material phases of the work of the Group were carried out by the section for Ship Preparation and Inspection, which had four main subsections, responsible for large target vessels, small target vessels, submarines, and non-target vessels. Working in close association with Capt. F. W. Slaven and Capt. F. X. Forest, the heads of this section, were four special assistants for hull, machinery, electrical, electronics, with the head of the Electronics Group as the fourth assistant. In late January, Captain Forest became officer-in-charge of target ship preparation and inspection, with Capt. W. S. Maxwell as machinery assistant, Comdr. J. W. Roe as hull assistant, and Comdr. E. H. Batcheller as administrative assistant. Capts. R. C. Bell and E. W. Lamons became members of the Group about that time, and until their departure in mid-February to become Crossroads representatives at Pearl Harbor, assisted in the preparation of the general instructions to target ships. Comdr. C. L. Gaasterland reported late in January for the specialized work required in preparation of submarines and Capt. P. S. Creasor joined the Group in February as electrical assistant.

Several other officers were ordered to the Bureau during the preparatory period to assist in the work of specialized units. Some of them, after brief indoctrination in the various phases of the project, proceeded to the different naval shipyards to progress ship preparations until re-assembly of the Group on the West Coast for departure for Bikini. Certain civilian specialists within the Bureau joined the staff on a part-time basis and then became fulltime members of the Group upon departure from Washington. Although not required during the preparatory stages, the services of several specialists from naval shipyards were engaged well in advance for the pre-test and post-test inspection work at Bikini. These men, who were selected for particular employment with boilers, turbines, pumps, cranes, and numerous electrical items, and specialties such as welding, reported to the Group just prior to the departure of the staff from the West Coast. Late in March, an officer from Mare Island Naval Shipyard became a member of the Group to study test effects on paint and chemicals, and two officers, one from the Philadelphia Naval Material Inspection Office, the other from the Bureau, joined the Group to supervise exposure and examination of navy fuels and lubricants.

One subsection on explosion phenomena was maintained by means of close liaison with the head of the Ships Instrumentation Group. Other subsections dealt with planning, progress, technical inspection, and naval architecture. The whole organization was kept fluid because of the necessity of accomplishing much of its work in scattered naval shipyards, both in United States and Pearl Harbor, and even the special assistants performed over-lapping duties in the field, as necessary. When the Director of Ship Material staff was reorganized enroute to Bikini Atoll, Captain Forest became head of the Bureau of Ships Group, and other members of the group were assigned staff duties involved in the technical inspections. This entire group was embarked in WHARTON.

Responsibility

In executing the tasks assigned its parent organization, the

Bureau of Ships Group became primarily responsible for readying the target and non-target ships for the tests as well as for inspection of damage. The Group was charged with carrying out the Director of Ship Material's Ship Preparation Plan¹ and Reboarding and Inspection Plan,² which were the important parts of the program for exposing naval vessels to the atomic bomb, according to the Operation Plan.

The first concern of the Group was that hull, machinery, and electrical gear of almost ninety target ships, plus reserve ships, ranging from landing craft to carriers and battleships, be placed in proper material condition. Each target ship must be furnished with instructions for liquid loading and ballasting. Special equipment and specimens from pigs to aircraft had to be provided for on designated ships. Electric power must be available on certain target ships, after they were abandoned by their crews, because of special equipment to be operating during the explosions. Scarce equipment vital to our operating fleets was to be removed. Crews must be indoctrinated, first about preparing their ships, then about inspection and reboarding. The 130 non-target vessels must be equipped not only to transport personnel and supplies, but to provide laboratory space for scientific groups in their study of oceanographic, radiological, and other phenomena, and to provide facilities for press and radio as well as many civilian observers.

Apart from the actual preparation of the target ships with regard to equipment under Bureau cognizance, the Bureau of Ships Group was responsible also for coordinating the special preparations required for exposure of materials by the other various groups under the Director of Ship Material and for the installations of equipment for the instrumentation groups. These were special tasks in support of the Director of Ship Material's work that affected all groups, especially as reflected in execution of the two Plans previously mentioned.

¹See Annex W: Ship Preparation Plan.

²See Annex X: Reboarding and Inspection Plan.

PREPARATION OF TARGET SHIPS

Preliminary

Since it was necessary that the target vessels be placed in the best possible material condition and that urgent repairs to hull, machinery, and electrical equipment be accomplished in the limited time available, the target vessels were assigned availabilities at the various naval shipyards. Previous to the first conference, instructions had been issued by the forces afloat directing all target vessels to proceed to the Naval Shipyard, Pearl Harbor, by 5 April 1946, where the repairs and preparations were to be made. Subsequently, it was realized that this procedure would inevitably create an overcrowded condition which would tax the facilities of that shipyard, with consequent detriment to the efficient and rapid preparation of the ships; and plans were therefore made to insure complete preparation of the large target ships prior to their arrival at Pearl Harbor from the United States. Work on the target Auxiliaries, Destroyers, Submarines, and Landing Craft remained the responsibility of the Naval Shipyard, Pearl Harbor, under the direction of target preparation representatives there. Conversion and modification of a large majority of the non-target ships was handled in the continental naval shipyards.

The Ship Preparation and Inspection Section, the principal agency under the Bureau of Ships Group, was organized into three sub-sections for target vessels--combatant ships, auxiliaries, and submarines--and one for non-target vessels. From time to time minor changes were made in the organization for practical reasons: for example, destroyers were transferred from the combatant to the auxiliary section because all these vessels were being prepared at Pearl Harbor where the auxiliaries had been assembled.

During the early days of the organization, all members of the Section worked together on the compilation and issuance of extensive general and detailed instructions for the guidance of the naval shipyards and the target ships, which provided the recipients with a concrete picture of their duties and responsi-

bilities in connection with the project. On the completion of the initial preparatory work, and as soon as personnel could be spared from the Bureau of Ships Group, officers were sent to the naval shipyards to assist and advise in the preparation of the target ships. This procedure proved more satisfactory for keeping yard activities up-to-date than the normal means of furnishing instructions by mail and dispatch.

The first of the units left Washington 8 February to expedite non-target conversions on the West Coast and a second unit left on 15 February to coordinate the destroyer program at Pearl Harbor. The Auxiliary and Landing Craft group followed on 23 February, and two days later, representatives for Carriers and Battleships proceeded to the West Coast, where individual officers were dispersed to the various naval shipyards preparing the major combatant target ships. The advance echelon of the Submarine section departed from Washington on 2 March, bound for Pearl Harbor. As various representatives left the Washington area, their duties were assumed by the remaining members of the Group, which remained as a central planning agency. Other officers of the Bureau of Ships Group were given intensive courses of indoctrination and ordered to the field.

General Preparations

During the Navy Yard availability of all of the target ships, the required preparation of the ships for the test was accomplished. The condition of structural strength and watertight integrity on each ship was checked, and any serious defects in vital machinery and equipment were corrected. Special instruments required by the various scientific groups were installed. Arrangements were made for the operation of special items of equipment on specified target vessels and for equipment that was to be in operation at the time the ships were abandoned for the tests. Instructions were disseminated to the crews covering their duties and responsibilities in connection with the tests.

Certain items of historical interest or of a critical nature were removed from the target vessels prior to the test, and

preliminary inspections, whose nature is covered more thoroughly in connection with the Reboarding and Inspection Plan, were accomplished. Loading of the target ships with specified amounts of ammunition, fuel oil, gasoline, water and special materials and equipment also was studied and detailed instructions issued. Ships were loaded as closely as possible to the battle or operating displacement of the ships. Varying percentages of the wartime allowance of ammunition and of the normal capacity of fuel, oil and gasoline were carried in the ships' magazines and bunker tanks.¹ All gasoline drums, airplanes loaded with gasoline, and similar items were placed in pans with coamings approximately eighteen inches high to prevent dispersal of the gasoline.

Since the effects of possible high waves on ships' anchoring facilities were unknown, it was necessary to devise special anchoring arrangements. It was planned that the ships be anchored with practically full scope of chain on one anchor; a second anchor chain was to be let out on short scope and hung in loops, secured by special fittings. The fittings, manufactured especially for this test, has been designed to permit fracturing of the fittings before the second anchor chain could be carried away, allowing the second chain to pay out as the ship moved. Representatives of the Group tested this anchoring arrangement on ships at Philadelphia, New London, and Pearl Harbor.

Heavy Target Ships

All of the heavy target ships to be used in the tests were prepared in continental naval shipyards, with the exception of the Japanese ships, NAGATO and SAKAWA, which received the necessary handling by repair ship after their arrival at Bikini. ARKANSAS, NEVADA, INDEPENDENCE, PENSACOLA, and SALT LAKE CITY were prepared at Terminal Island, NEW YORK and PRINZ EUGEN at Philadelphia, PENNSYLVANIA at

¹See Chapter: DEVELOPMENT OF THE TARGET ARRAY:
Mooring and Loading Problems.

Puget Sound, and SARATOGA at San Francisco. NEW YORK and PRINZ EUGEN were retained on the East Coast so that they would be readily available to ship preparation personnel and others for study with Ship's force of staff inspection procedures. They also were used for the initial indoctrination of ship radiological monitors. Numerous visits were made to NEW YORK, particularly by the officers of the combatant ship unit, in order to obtain information for use in the preparation and ironing out of many procedures to be undertaken on the remaining target ships. The Commanding Officer of NEW YORK rendered invaluable assistance by preparing a pattern ship's Organization Bill to meet the special requirements of the tests. This Bill in its final form was adopted by all target ships.

Certain ships posed individual problems whose solutions were accomplished in addition to the routine preparation activity. It was discovered, for example, that PENNSYLVANIA had a weak spot in the strength of the hull, the result of crude repair of a torpedo hit which tore away the ship's shell on 12 August 1945. The shell had not been replaced, and the hull was merely covered with a cofferdam patch which did not replace the original strength of the vessel in the vicinity of the missing shell plating. It was believed that the patch would in all probability fail sufficiently prior to the completion of Operation Crossroads to allow the torpedo damaged area to flood completely. It was directed that the Naval Shipyard Puget Sound, examine and reinforce or tighten as necessary the water-tight boundaries of the torpedo-damaged area in order to prevent progressive horizontal flooding in the event the cofferdam patch was either partially or wholly carried away. Since the steam steering engine shaft passed through the torpedo damaged area, it was considered necessary to install a water-tight box completely around the shaft, so that the flooding of the damaged area would not cause failure of the shaft due to the immersion of the shaft bearings in salt water.

In order to provide Diesel-electric power for equipment to be kept in operation for Test Able on PENNSYLVANIA, it was decided to install a Bureau of Yards and Docks 75 kilowatt 440-volt, three-phase AC Diesel generator of the advance base type in casement 7 on the upper deck. The generator had been obtained from the Advance Base Depot at Tacoma through the

cooperation of that base with the Puget Sound Naval Shipyard, and was released for this use by the Chief of Naval Operations. In order to provide a small quantity of direct current power, an 8-kilowatt AC-DC generator set was obtained from salvage by the yard forces and installed in the same compartment as the Diesel set. The installation and preliminary test of the generator set were completed on 14 March.

It was necessary to install emergency battery power aboard the point-of-aim ship, NEVADA, to provide an emergency supply for the navigation radar beacon. NEVADA was painted international orange-yellow, and a dual emergency steering gear was installed in her for special exposure in the tests.

Foodstuffs carried on board the ships were reduced to the minimum consistent with subsisting the crews until 1 July. All fresh water tanks, with the exception of the emergency reserve feed water tanks, were kept as full as practicable by the use of evaporating plants. Fuel oil was supplied to the allowances agreed upon, and potable and reserve feed water tanks and salt water ballast tanks were filled only to ninety-five percent capacity instead of the usual one hundred percent in order that sounding could be used to detect leakage due to damage resulting from the explosion. Since it was necessary that all ships be upright at the time of the test, list was removed by transferring oil in the service tanks, and in some cases by ballasting additional tanks.

Light Target Ships

The target Auxiliaries, Destroyers, Submarines, and Landing Craft were prepared at the Naval Shipyard, Pearl Harbor. In general, the same methods of preparation were applied to the light target ships as to the heavy target ships. Individual problems also arose in the handling of the light target ships. For example, fourteen of the target destroyers had only one hawse pipe, and it was necessary to fabricate and install portable davits in order to handle the second anchor required for Test Baker. The generators scheduled to be carried in the forward hold of APA-61 were placed in the after hold in order

to simplify their installation, and other units were shifted as required. Special test runs of the emergency diesels in destroyers and auxiliaries were made to analyze power requirements for the equipment which was to be in operation on certain ships during the tests. Mooring tests under realistic conditions were carried out with one of the target destroyers to check the specially designed chain shackles. Much electrical wiring had to be done to meet instrumentation requirements. Other specific problems were involved in the loading of aircraft and test materials on the auxiliaries. The submarines were in themselves a definite problem.

Target Submarines

The eight target submarines, all of approximately equal displacement, were selected from those scheduled for the reserve fleets or for disposal by scrapping. They represented the two major types, light and heavy hull construction, built in recent years by the three submarine building yards of the Electric Boat Company and the naval shipyards at Portsmouth and Mare Island. Insofar as compatible with other requirements, the ability to meet the originally urgent schedule was a determining factor in the selection of the vessels. All of the submarines were in fair-to-excellent material condition, with the exception of the radar and sonar equipment on SKIPJACK and SEARAVEN. No alterations were required for the Operation and no major repairs were necessary. Four submarines were already in Pearl Harbor at the inception of the program, and the remainder of the group arrived there during the first half of February.

Submarines at Pearl Harbor

Upon assembly at Pearl Harbor, the Crossroads submarines were organized into Submarine Squadron Eleven. Upon the arrival of the advance echelon of the Crossroads Subma-

rine Unit at Pearl Harbor, efforts were made to familiarize the operating personnel of the submarines with the procedures to be followed in the tests. The advance echelon directed the design and assembly of special material for mooring, submerging, and salvage, and conducted rehearsals of mooring, remotely controlled diving, and boarding procedures. Necessary overhauls were undertaken, and the installation of special mooring, submerging and salvage fittings, and instrumentation brackets was accomplished. Each vessel was assigned a four-day availability at the shipyard for this purpose.

It was planned that the ships' crews should be responsible for preparations for the tests, including detailed inspection, loading, repair and upkeep, and the carrying out of special tests, as well as transit to the target area, mooring, assistance to the salvage forces, and repairs. Submarine instrumentation, consisting of hull deflection battens, mechanical strain gages, and velocity meters, was furnished by the Bureau of Ships and installed by the Naval Shipyard, Pearl Harbor, under the direction of the Ships Instrumentation Group.¹ With the exception of the instrumentation and mooring gear, no special equipment was provided.

Concrete Barges and Floating Drydock

The Crossroads Unit at Pearl Harbor also supervised the preparation of three concrete vessels of the Bureau of Yards and Docks, a floating drydock, ARDC-13, a gasoline barge, YOG-83, and a fuel oil barge, YO-160, the latter two having Maritime Commission hulls. These vessels were used by other groups for the exposure of test materials and the mounting of instruments. The Bureau of Yards and Docks had been interested in the damage to reinforced concrete structures at Hiroshima and Nagasaki, but the lack of suitable land areas at Bikini made construction of similar installations impractical, even if there had been time. The participation of this bureau,

¹See Chapter 9: RESPONSE INSTRUMENTATION.

therefore, was confined in a proposal dated 5 February to floating structures of reinforced concrete within the target array, and the three vessels were chosen from craft scheduled for disposal. The Bureau of Yards and Docks was represented on the staff of the Director of Ship Material by a small group to inspect these vessels.

Ship Measurements and Reference Planes

The Bureau of Ships Group requested naval shipyards to make watertight integrity studies and air tests of designated compartments of target ships. When this program seemed inadequate for obtaining the full measure data that would be required for damage analysis, Captain Forest organized a Ship Measurements Team early in February under the direction of Comdr. J. B. Shirley, who drew experienced personnel from the naval shipyard at Norfolk. The team was to determine how a target ship's main hull girder reacted in the tests. This required surveying the hull and establishing reference planes as a base for measuring deflections, with a thorough structural report on the ship before the tests. During the middle of February, this team worked on NEW YORK and PRINZ EUGEN at Philadelphia. Compartments were tested on the quarter lengths and bow and stern by closing up the compartments, applying a known pressure, and observing the static drop in a given period of time. This information could be compared with data taken after the tests as a measure of the effectiveness of welding, riveting, and other structural details.

Twist Pendulums and Deflection Gauges

After this preliminary work in Philadelphia, members of the team went to shipyards on the West Coast and Pearl Harbor to work on target ships there, and early in May, several members went to Bikini to inspect NAGATO and SAKAWA. By this time the program had grown until it included the installa-

tion of twist pendulums and deck deflection gauges, and studies of machinery foundations and turret structures. The main decks of target ships were surveyed for establishing reference planes which would allow damage studies of fundamental hull deflections peculiar to ships, such as hog, sag, twist, bow, and combinations of these; and additional data were to be provided by the installation of pendulums throughout the ships. The team arranged for shipyards and services afloat to install simple deck deflection gauges for measuring compression or expansion between weather decks and decks immediately below, so that studies of the rigidity and flexibility of panel structures could be made. Other simple means were used for measuring the relative motion between machinery foundations and hull structures, with similar measurements for ordnance structures.

Magnitude of Ship Preparation Task

A good idea of the magnitude of the work required in preparing the major combatant ships as targets for Operation Crossroads may be obtained from the following list, which is abridged, of the work performed on each of these ships in West Coast shipyards:

(a) Full structural examination in accordance with instructions; (b) Air test of quarter point and extreme end compartments; (c) Check of last report on water-tight integrity of each compartment throughout ship; (d) Repair of compartments as necessary to prevent possible progressive flooding; (e) Complete examination of underwater body; (f) Preparation of docking report; (g) Test of fire room pressures; (h) Hydraulic test of boilers; (i) Establishment of surveyors and water level planes; (j) Establishment of vertical and horizontal reference lines for list and twist determination; (k) Establishment of location marks for turbines, gears, boilers, steering machinery, and machinery units in turrets; (l) Installation of deck compression gages; (m) Installation of wiring, holders, and foundation for instrumentation; (n) Installation of racks for exposure of special equipment; (o) In-

stallation of special boarding ladders on shell plating from water-line to deck edge; (p) Preparation of boarding bill; (q) Preparation of bill for closing vessel for the tests; (r) Preparation of damage inspection bill; (s) Training of ships' crews in above organization bills; (t) Establishment of and instruction in procedures for starting and running special equipment to be in operation at the time of the tests; (u) Installation of pans and drains under equipment containing gasoline and/or combustible materials; (v) Painting of frame numbers; (w) Photographic record of all special installations; (x) Establishment of inspection routes; (y) Full preliminary inspection of all equipment with data recorded in special test forms.

PREPARATION OF NON-TARGET SHIPS

Preliminary

Relatively few of the 130 non-target vessels assigned to the Task Force required conversion or modification to fit them for their proposed assignments. But a number of the ships, especially those serving as headquarters for the various groups, underwent considerable modification, principally in continental naval shipyards, to adapt them to the technical requirements of Operation Crossroads. It was necessary to provide adequate accommodations for more than the normal complement of most of these ships. Office space and equipment were essential for the administrative work to be carried on, and various technical groups required laboratories and other scientific facilities. Most of the work in converting these vessels offered no difficulty apart from the fact that a very limited time was available. The additional communications facilities, required both for the operation itself and for public relations, were provided by the Electronics Group.¹

Task Force Flagship

MOUNT MCKINLEY was assigned as the Task Force Flagship, and certain minor alterations were necessary to fit her for this duty. The work was performed during a period of availability at the Naval Shipyard, Mare Island, in March. Approximately forty more desks were provided in a starboard compartment, and air-conditioning equipment was installed in the two wardrooms, the three staff cabins, and their associated staterooms. Certain television, radio-teletype, and other communication facilities were added, and weight compensation was made by the removal of light anti-aircraft weapons.

¹See Chapter 8: TECHNICAL COMMUNICATIONS.

Director of Ship Material Ship

A Separate ship was needed to transport the Director of Ship Material and the various ship preparation and inspection groups under his command. The ship selected must necessarily provide good accommodations for over two hundred officers, excellent small boat facilities, and adequate office space. Efforts were made first to obtain APA-89 or APA-90 either of which had excellent accommodations and would have required little modification; but these vessels, scheduled for early release to the Army Transport Service, could not be made available. Consideration was given to the utilization of two APA's of the APA 30-to-56 class or the APA 92-239 class, but the need for excessive conversion made either choice impracticable. No CVE or AV was available. In mid-February, WHARTON, AP-7, was assigned and was granted availability at the Naval Shipyard, San Francisco. At the time of its selection the vessel was on its way to Yokohama and was not scheduled to return to the United States until 15 March. Since it was desired to make use of this ship not later than 3 April, its conversion required immediate completion. The troop officer bunk rooms were modified into bunk rooms for six to eight persons, with appropriate desk space, and office equipment was installed in the space made available by the removal of the messing facilities from the forward troops' mess. A conference room and extensive communications facilities were installed.* Certain operating facilities such as blue-print room, file room, and photographic film stowage were provided. Nine personnel boats were added to augment the ship's limited small boat facilities.

Instrumentation Ships

The Naval Shipyard, Mare Island, converted HAVEN, AH-12, into a vessel suitable for the Radiological Safety Section, the Damage Control Safety Section, and the Presidential Evaluation Commission. Few changes of a permanent nature were required. Moderate laboratory facilities were fitted, and the wards and surgical dressing rooms were modified to provide

berthing facilities for officers and civilians. Medical personnel were removed with the exception of two doctors and one dentist. The conversion of HAVEN was executed in such a manner that it could be refitted as a hospital ship within forty-eight hours.

CUMBERLAND SOUND, AV-14, was converted at the Naval Shipyard, Terminal Island, for the use of Los Alamos representatives. The conversion consisted principally of the provision of additional **berthing** for the transportation of 119 passengers and the provision of air-conditioned laboratory spaces and antenna arrangements to house the extensive radio linkage systems employed in Test Baker.

BURLESON, APA-67, originally one of the target APA's, was converted to an animal transport, for the use of the Naval Medical Research Section, at the Naval Shipyard, Mare Island, during February and March. Most of the animal work was scheduled for Test Able, and it was considered that BURLESON's services as an animal ship could be dispensed with if it became necessary to utilize the ship as a replacement target in Test Baker. The principal features of BURLESON's conversion were the provision of animal pens, laboratories, autopsy rooms, feed bins, and accommodations for seventeen medical officers.

When it became apparent that insufficient space existed elsewhere, AVERY ISLAND, AG-76, was assigned to the Task Force for the use of the Electronics Group. Extensive conversion work was necessary to provide officers' berthing and messing accommodations, three air-conditioned laboratory spaces in the former electronics ship, and seven plane personnel boats to the ship's allowance. In addition, the ship was fitted out as a mobile issue office for registered publications for the Task Force. AVERY ISLAND's normal function as an electronics repair ship was so impaired by its conversion that another electronics repair ship, COASTERS HARBOR, AG-74 was assigned to the Service Division of the Task Force.

Press and Observer Ships

APPALACHIAN, AGC-1, was converted into a press ship during her availability at the Naval Shipyard, Terminal Island,

through February and March. Part of the crew's living spaces were converted into bunk rooms adequate for twenty-four officers or press correspondents, and the wardrooms were air-conditioned. BLUE RIDGE, AGC-2, was made available at the Naval Shipyard, Terminal Island, and PANAMINT, AGC-13, at the Naval Shipyard, Mare Island, for conversion to observer ships to carry representatives of Congress, the Armed Forces, the United Nations, and other special observers. The principal modification to these ships was the provision of air-conditioning in the wardrooms, the three staff cabins, and associated state-rooms.

Bomb Carrying Ships

The AV-5, ALBEMARLE, was designated in mid-January for conversion to a bomb carrying and assembly vessel. This conversion was accomplished by Naval Shipyard, Terminal Island, working directly with various representatives of the Los Alamos Group. Principal modifications involved provision of air-conditioned laboratory spaces, jettisonable storages, and radio-teletype facilities for the use of the Deputy Task Force Commander for Technical Direction.

When a decision was reached about 28 February to proceed with preparations for a sub-surface shot for Test Baker, LSM-18 was ordered made available at Naval Shipyard, Terminal Island, for conversion to a laboratory ship to handle the bomb for this shot. The choice of an LSM was based upon stability characteristics and space available for handling of the large and heavy bathysphere necessary for the sub-surface shot and for receiving the necessary remote timing and firing signals. Capt. A. M. Morgan was placed in complete charge of the project. After his inspection of LSM-18, which was in bad state of repair, he requested a substitution and LSM-60 was made available. Conversion consisted principally of provision of a center-line well, with handling equipment over the well, and two air conditioned laboratory spaces with a radio mast. Design and fabrication of the bathysphere was accomplished at Naval Shipyard, Portsmouth, New Hampshire.

REBOARDING AND INSPECTION

Preliminary

The Reboarding and Inspection Plan was evolved to provide a means of determining the effect of the bomb explosion on a formation of ships moored in close proximity, their structure, equipment, and machinery, special items of Army and other equipment, the physical and chemical properties of various types of material, and to determine the radius of effectiveness of the bomb used in the tests. Photographic studies, laboratory studies of selected specimens, visual examinations, readings from special instruments, and actual operating performance of machinery and equipment were to be the means of obtaining the requisite data.

Preliminary Inspections

At the point of departure, it was essential that the condition of the target vessels be known in the most complete detail possible. Preliminary inspections were made by the ships' crews, naval shipyards, technical personnel, and representatives from the staff of the Director of Ship Material. These inspections were documented with photographs of significant damage or derangement and of the special materials loaded aboard the ships, as well as a standard set of photographs of each ship. In addition, reference planes were established by survey in the ships to provide a basis for determining major hull distortions.

The effects of the tests were established by comparing the condition of the ships as revealed by inspections after each test with the conditions indicated by the original inspections. Every effort was made to insure differentiation between damage due to the tests and damage attributable to secondary effects such as fire and ammunition explosions. The same general procedure was established for determining the effect

of the tests on the special materials exposed aboard the target vessels.

Inspection Instructions

It was apparent that the maximum data must be obtained prior to the tests, so that any damages, particularly of an unexpected nature might be determined as definitely attributable to the tests. For the purpose of the tests, it was concluded that a complete set of instructions setting forth procedures and providing forms for the use of the ship's force was essential. These instructions, developed and prepared by the Bureau of Ships Group and the Bureau of Ordnance Group, were set forth in the so-called "Blue Book" and "Red Book", both entitled "Instructions to Target Vessels for Tests and Observations by Ship's Force".

The inspection forms and instructions were prepared in such a manner as to provide for segregation of individual classes of equipment on each ship, so that the performance of like equipment or material on numerous target vessels could be prepared by extracting portions of the reports of individual ships. The tests and inspections by the ships' forces were designed to provide complete and detailed information on the condition of the ship, its equipment and machinery, and all similar factors before and after each test.

It was foreseen that the inspections of the nature outlined above must be limited to the capacity of the ship's forces and that further observations of a more technical nature must be provided for. The concept of a Staff Technical Inspection was evolved to achieve this purpose. It provided for technical inspections by competent technical observers assigned to each of the activities for which the Director of Ship Material was responsible. These inspections were designed to insure that specific points of technical significance were observed and reported.

In addition, each naval shipyard at which target vessels were prepared was requested to make certain structural and ordnance examinations in order to establish a complete over-

all picture of this material. The naval shipyards were also directed to make watertight integrity studies and air tests of certain designated groups of compartments in order that the condition of these compartments before and after the tests could be established, providing a further criterion of overall damage.

The ships measurement team, made up of personnel from the Philadelphia and Norfolk Naval Shipyards, proceeded to establish on each target vessel basic reference planes which were to be checked prior to the tests and between and after Tests Able and Baker. The reference planes provided means for checking changes in fore-and-aft shapes of the ship, twist and overall deflections of bulkheads, decks, and deckhouses, and transverse changes in the shape of decks.

To insure adequate coverage of damage observation, each target vessel was instructed to designate a Target Coordinating Officer and a Damage Observation Officer. The Target Coordinating Officer's duties involved the coordination of the records on board each target vessel, the removal of samples, and the coordination of the various inspection activities boarding the ships for inspection purposes. The Damage Observation Officer maintained direct contact with the problems of the inspecting personnel to insure that their instructions relative to measurements, photographs, removal of samples, and so on, were made clear to ship personnel and were followed expeditiously. It was anticipated that since the latter officer would be aboard the ship for a much greater period of time than any individual technical observers of the staff, he would be able to collect and note many items of particular interest.

Inspections After the Tests

At an early date, it became apparent that the problems of re-entry and control of inspection in the field were of major proportions. There was evolved a plan for the control of inspections in the field, set forth in detail in the Reboarding and Inspection Plan, which relates to the provision for initial

boarding of the target vessels.

In order to avoid inordinate delay it was planned that vessels carrying key observing and inspecting personnel, including the ships' crews from the target vessels, would enter the Lagoon at the earliest practicable moment after radiological safety had been established, and anchor in close proximity to one another and to the target formation.

An Initial Boarding Team, composed of the radiological safety monitor, medical safety officer, bomb and ammunition disposal or safety officer, technical representatives of the Director of Ship Material, and photographer, was the first unit to board each target vessel. The Initial Boarding Teams were ordered to observe and record the extent and general nature of the damage; and by means of a topside survey to recommend the next step in the inspection or disposition of the vessel. The Director of Ship Material was authorized to determine the order of successive boarding parties, upon the recommendation of his representative on the Initial Boarding Team. The operations of all Teams were supervised by the Director of Ship Material, who, with the head of the Salvage Unit, was embarked with one Initial Boarding Team in order to observe damage first-hand.

The technical inspection of the target vessels which followed was to be conducted by officers and civilian specialists of the Bureau of Ships Group in accordance with detailed instructions designed to utilize the experience gained in many observations of war damage to ships. Other Groups were to conduct similar technical inspections on material under their cognizance.

SUPPORT OF TEST OPERATIONS

Assembly of Staff

The departure of remaining staff members from Washington about 29 April had been timed to allow for a final check of preparations and a rehearsal of operational procedures after arrival at Bikini. Representatives of the Bureau of Ships Group who had been working in West Coast shipyards boarded WHARTON just prior to its departure on 6 May, and those attached to the units at Pearl Harbor joined the Group shortly after WHARTON's arrival there. During the stop-over at Pearl Harbor, the entire Bureau of Ships Group was together for the first time. Frequent conferences were held to acquaint all personnel with the aspects of the operation which would be of importance to the Group, and civilian technical personnel made numerous acquaintance inspections to familiarize themselves with representative types of target ships. Organized units made simulated damage inspections and wrote subsequent simulated damage reports in order to become familiar with the general character of this report. Upon departure from Pearl Harbor, the staff reorganized to shift from the ship preparation phase to the approaching damage inspection phase.¹

Final Pre-Test Inspections

Concurrent with the staff re-organization, the Bureau of Ships Group established the basic inspection teams which were to be used during the test operations. A broad Organization Bill set forth three possible combinations of teams for damage inspections: one, in which all members of the group were divided into two teams to provide rapid coverage of badly damaged target ships; another, in which all members were

¹See Chapter 1: DIRECTOR OF SHIP MATERIAL: Staff for Technical Inspections.

arranged in six teams to provide coverage of the maximum number of ships; and a third, in which all members not assigned to Initial Boarding Teams were assigned in three groups to assist as necessary during the initial re-boarding operations. The entire Group functioned administratively through the three units for hull, machinery and electrical and a special sub-section for submarines. The teams included members from all units. Unit heads prepared detailed lists of the items to be checked during the final pre-test inspections and shortly after arrival, teams operating under the six-team combination, for indoctrination in inspection procedure, commenced visits to all of the target ships to insure compliance with final instructions and completion of forms.¹ Ship measurement teams also resurveyed reference planes established during the shipyard availabilities of the target ships. The final inspections showed that preparatory work accomplished in shipyards and the training of target ship crews had been well done. The pre-test inspections were completed about 15 June and members of the Group spent the last two weeks prior to Test Able in active participation in the Initial Boarding Team drills and smoothing out post-test procedures.

Test Able Operations

Nearly all officers of the Bureau of Ships Group were assigned to the various Initial Boarding Teams outlined in the Initial Boarding Plan.² These officers acted as technical representatives or assistant representatives for the Director of Ship Material and were responsible for safe clearance of target ships after the Test Able burst.³ Re-entry on Able Day and

¹See this Chapter: REBOARDING AND INSPECTION: Inspection Instructions.

²See Annex X, App. X: Initial Boarding Teams.

³See this Chapter: REBOARDING AND INSPECTION: Inspections after the Tests.

re-boarding operations completed on Able plus Three occurred without incident. After clearance of the ships, members on the Initial Boarding Teams rejoined the Group which commenced technical inspections. In order to expedite the inspections, it was found convenient to modify the inspection organization. Instead of the merged teams consisting of members from all units, teams with members from a single unit conducted inspections of material under their cognizance. As inspections were conducted, the Unit leaders maintained Progress Charts from which information was obtained for the daily progress summaries submitted to the Target Inspection Officer. The data obtained by the teams during preliminary inspections of the target ships were included in the Bureau of Ships section of the Director of Ship Material's Gross Damage Report for Test Able, submitted on 5 July. More detailed results accruing from further inspection were included in a similar section of the Interim Report for Test Able. In addition to the technical inspections, certain members of the Bureau of Ships Group assisted in damage repairs and salvage operations. Assessment of the results of Test Able was complete by mid-July and technical inspection teams commenced checking readiness of the ships for Test Baker.

Test Baker Operations

Although re-organized teams were listed for Test Baker, members of the Bureau of Ships Group again participated as technical representatives or assistant representatives for the Director of Ship Material. Re-entry on Baker Day and re-boarding operations that followed, which are described elsewhere², proceeded slowly as anticipated. Due to the delay in

¹See Chapter I: OPERATIONS DURING TEST ABLE:
Control of Inspections.

²See Chapter I: OPERATIONS DURING TEST BAKER:
Re-entry into Lagoon. Technical Inspections.

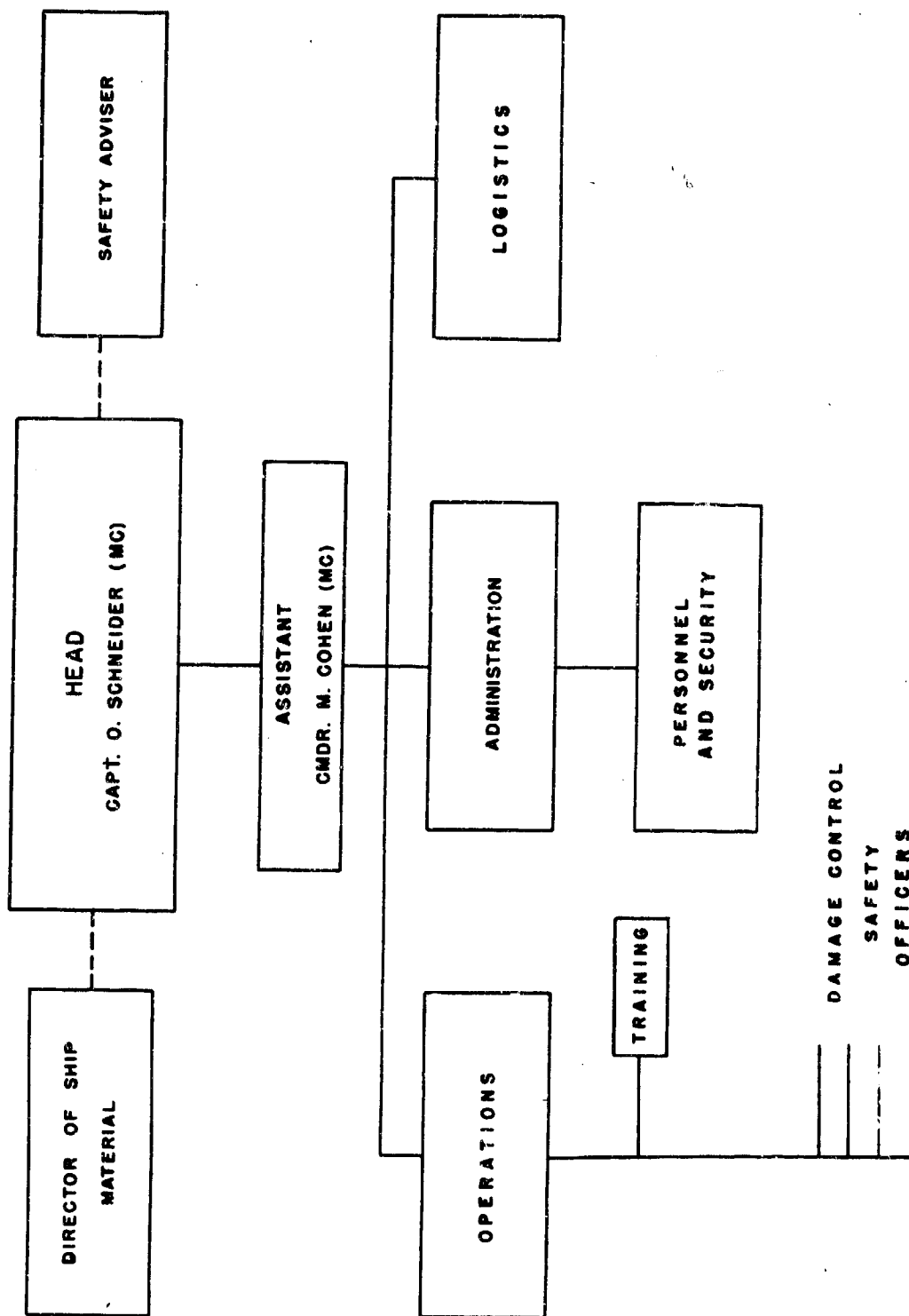
safe re-boarding imposed by the radiological hazards, Initial Boarding Teams were disbanded after clearance of only a few ships on the outer periphery of the array. The Group members then engaged actively in experimentation with decontamination processes in conjunction with the Director of Ship Material and the Salvage Unit. Certain members of the Group conducted salvage and pumping operations while other members made technical inspections as ships were cleared. Daily progress summaries were again submitted by the Group to the Target Inspection Officer. During the latter phases of the operation, re-assignment and demobilization caused a reduction in personnel which hampered rapid completion of inspections and reports. The section submitted by the Group on 5 August, for the Gross Damage Report, was quite brief due to the limited inspections, but the section submitted for the Interim Report on 27 August, after inspections were completed, showed a detailed assessment of the results of Test Baker. Operations in the Bikini area were concluded on 25 August, and the Bureau of Ships Group departed in WHARTON for Kwajalein on that date. Arrangements were made for further observations of target ships at Kwajalein, and Comdr. J. B. Shirley, a member of the Bureau of Ships Group, was assigned to the staff of Commander Naval Task Groups as technical representative for Director of Ship Material to assist in continued decontamination and inspections.

The Bureau of Ships Group arrived in San Francisco on 7 September and re-assembled in Washington in offices provided by the Bureau of Ships on 23 September to undertake preparation of the final reports.

CHAPTER 3

DAMAGE CONTROL SAFETY SECTION

DAMAGE CONTROL SAFETY SECTION (014-MI)



DAMAGE CONTROL SAFETY SECTION

Formation of Section

Early in February, attention was given to hazards other than radiological in reboarding the target vessels for inspection after the burst, and the Safety Adviser of the Task Force, Capt. G. M. Lyon, (MC), USN, formulated a preliminary plan for a Damage Control Safety Section, which would be responsible for determination of these hazards. On 19 February, Capt. O. Schneider, (MC), USN, was appointed head of the Section. After conferences with the Safety Adviser, who explained the relationship of this Section with the Radiological Safety Section under Col. S. L. Warren (MC), AUS, in the general safety plan for the Task Force, Captain Schneider conferred with members of the Bureau of Ships Group concerning personnel and training for carrying out their safety requirements in reboarding and inspection.

The Damage Control Safety Section was organized, like the Naval Medical Research Section,¹ as one of the two sections under the Medical Group. In effect, if not in the organizational schematic, the Damage Control Safety Section formed a part of the general safety organization of the Joint Task Force. Its administration was patterned after that of the Task Force, and comprised a personnel section, a security section, an operations section, and a logistics section. The operations section included the Damage Control Safety officers who operated with the Director of Ship Material teams. The functions of planning and training were carried out by the head of the Section and his assistant. The Section was embarked in HAVEN along with the Safety Adviser and the Radiological Safety Section.

¹See Chapter 7: NAVAL MEDICAL RESEARCH SECTION

Responsibility

The general responsibility of the Damage Control Safety Section was support of the Safety Plan,¹ which covered all personnel hazards, radiological and non-radiological. Specifically, the Section was responsible for carrying out the principal non-radiological part of the Safety Plan.² Since it must protect personnel from hazards incident to material damage to target ships, this Section functioned in the organization of the Director of Ship Material, where it was responsible for the development and execution of the plan to provide this protection as well as for the training of personnel for this purpose and procurement of necessary material. In this connection, the Section supported the Reboarding and Inspection Plan.³

¹See Annex E: Safety Plan

²See Annex E, App. III: Damage Control Safety Plan

³See Annex X: Reboarding and Inspection Plan

SUPPORT OF THE SAFETY PLAN

General Considerations

It was assumed that the explosions would produce sufficient damage to inner ships of the target array to give rise to conditions hazardous to reboarding personnel, damage resulting primarily from blast and heat, or damage occurring secondarily as the result of the burning or explosion of ammunition, fuel oil, gasoline, or other material. There were obvious physical hazards, such as loosened structure, flooded compartments, and heat produced from ruptured steam lines, fires, and secondary explosions. Chemical hazards, which seemed more formidable, might arise from toxic concentrations of carbon monoxide, reduction of oxygen in compartments, nitrous gases from burning lacquers and film, refrigerant gases, and fuel vapors, as well as from chemical warfare munitions loaded on certain target ships.

Physiological hazards, such as the use of contaminated food and drinking water and the effects of excessive heat also had to be avoided. To effect its safety program, the Section planned to provide a Damage Control Safety Officer, specially trained, for each of the Initial Boarding Teams, which were to give clearance for reboarding to the ships' crews and to Technical Inspection Groups under the Director of Ship Material. These safety officers were to be provided with equipment and instruments commonly used for detection of toxic gases and vapors.

Training

Since medical personnel were to be concerned with problems of damage control, a training program was necessary. Late in February, arrangements were made with the Damage Control Section of the Bureau of Ships to send ten Hospital Corps officers, who had recently reported, to the Damage

Control Training Center at Philadelphia for a week's intensive training.

Six medical officers, reporting later, also received the same training. The Industrial Medicine Section of the Bureau of Medicine and Surgery provided lectures and demonstrations at the Naval Gun Factory on industrial hazards and detection of toxic gases. Plans called for additional training in general and technical subjects such as nuclear physics, theories of damage control, communication procedure, and use of technical equipment.

Instruction of Target Ship Personnel

By 25 March 1946, the preliminary training was completed and thirteen officers of the section proceeded to the West Coast. Lt. (jg) A. L. Rogers, Logistics Officer, established headquarters at the Oakland Army Base and from there, he was able to facilitate the procurement and movement of equipment and supplies to HAVEN. In addition, he was to handle transportation problems, and arrange for living and working spaces aboard ship. Since additional time was made available by the postponement of the tests, the other twelve officers began a program of familiarizing themselves with target vessels at San Pedro and San Francisco.

An important part of this program was the education and indoctrination of the crews of these target ships in all matters pertaining to Damage Control Safety, and assistance in the organization of the ships reboarding teams into efficient working units from the standpoint of accident prevention. This program was continued until HAVEN sailed for Pearl Harbor on 29 May 1946, at which time all the personnel were embarked aboard that vessel except Comdr. M. Cohen (MC), USN and Lt. S. V. Golas (HC), USN; The latter two officers had already departed for Pearl Harbor aboard WHARTON on 6 May, to continue the indoctrination program and to maintain liaison between the Director of Ship Material aboard WHARTON and the main body of this Section aboard HAVEN. They instructed the crews of target ships at Pearl Harbor and Bikini in safety

matters and also gave lectures and demonstrations for Director of Ship Material personnel aboard WHARTON. Arrangements were made to procure safety equipment for the target ships lacking these items through the supply depot at Pearl Harbor and by air from supply points in the United States. The Force Maintenance Officer aboard MOUNT MCKINLEY assisted in these supply problems.

Meanwhile, aboard HAVEN, this Section was rounding out its own training and indoctrination program by working with the Radiological Safety Section in lectures, demonstrations and conferences.

The final steps were taken when all the ships arrived at Bikini. Two Safety conferences were held at Bikini Island Officers Club on 12 June and 13 June for the Commanding Officers, Damage Control Officers, Target Coordination Officers and Medical Officers of all target ships, and Initial Boarding Team members from the staff of the Director of Ship Material. At these conferences, plans were presented for assuring that safe conditions were maintained in target ships during the re-occupation and technical inspections of the vessels.

Operational Procedure

The Safety Plan provided that the Damage Control Safety Section be embarked aboard HAVEN along with the Radiological Safety Section. The Damage Control Safety Officers formed part of the Initial Boarding Teams, standing midway, in time, between clearance of the area by the Radiological Safety Section and reboarding by the ships' crews. The function of each Damage Control Safety Officer, after assessing hazards on the target vessels, was to keep the Director of Ship Material representative in the party informed of the presence of all hazards observed, so that this information could be relayed to the Task Force headquarters and the Director of Ship Material. It was anticipated that these officers might have to remain aboard certain heavily damaged target ships, if instructed by the Director of Ship Material, to advise the returning ships' crews about hazards present in the vessels.

The assignment of individual Damage Control Safety Officers to the various Initial Boarding Teams was made in accordance with the Initial Boarding Plan.¹ Initial Boarding Team drills were held on 15 June and 19 June and details of communication and task assignments were further developed.

Test Able Operations

The Queen Day rehearsal indicated no need for major changes in the plans for reboarding on Able Day. Shortly after the atomic bomb burst on Able Day, the ships carrying Initial Boarding Teams began their approach for re-entry into Bikini Atoll and during that afternoon these teams boarded and inspected the topside of most target ships in the radiologically clear areas of the Lagoon.²

The initial boarding of all target ships was completed on Able Day plus three. By that time the ships which had been declared safe were being opened up by their own ship's force teams. In general, operations of the Damage Control Safety Section were carried out successfully and without any particular difficulties. There were few occasions on which it was found necessary to employ the safety testing equipment, since nearly all of the Initial Boarding Teams inspections were limited to the topsides of vessels. During the entire test there was no report of any injury to personnel which could in any sense be attributed to the bomb explosion or to subsequent events and operations incident to the test. It appeared that the Safety Program had succeeded in making all personnel safety-conscious and had thereby yielded the desired results.

¹See Annex X: App. X: Initial Boarding Teams.

²See Chapter 1: OPERATIONS DURING TEST ABLE:
Re-entry into Lagoon.

Test Baker Operations

During the interval between the completion of initial boarding after Test Able and the rehearsal on William Day, there was no active participation by safety officers of the Damage Control Safety Section in the technical inspections of target ships. The ships' force teams, properly equipped and well indoctrinated in safety measures, proceeded to reboard and reopen their ships unassisted and without accident to personnel.

Little change in the plans of the section appeared to be necessary in preparation for Test Baker. It was anticipated that excessive radioactivity might cause considerable delay in reboarding the targets, and that when reboarding did take place, greater precautions would have to be taken when opening below deck spaces owing to this delay, as well as to the greater structural damage which was expected.

For the William Day rehearsal, when initial boarding was accomplished with small boats, the Damage Control Safety Officers and the Radiological Safety Monitors assigned to Initial Boarding Teams remained on HAVEN and were picked up by their respective teams as needed. For Baker Day, the Director of Ship Material rejected this plan and directed that all members of Initial Boarding Teams be embarked in their respective salvage vessels as for Test Able. A similar re-entry was executed on Baker Day but Initial Boarding Teams inspected only a few ships on the outskirts of the target array. The inner part of the array was too radioactive to be approached for any practicable length of time.

HAVEN re-entered and anchored near the entrance of the Lagoon and the majority of the Safety Officers returned aboard. Operations on succeeding days are described elsewhere.¹ It is only necessary to state here that in all of these operations, whether they involved beaching a damaged vessel, reboarding, or attempting various decontamination procedures, a member of the Damage Control Safety Section was on hand to take what-

¹See Chapter 1: OPERATIONS DURING TEST BAKER:
Re-entry into Lagoon. Technical Inspections.

ever action might be required in order that the task be safely accomplished.

Post-Test Operations

The reboarding, inspections, and salvage of target ships proceeded slowly but satisfactorily. The presence of the entire section was not required for the remainder of the operations at Bikini and on 5 August, four members of the section, including Capt. Schneider, returned to Washington to commence work on the final reports. Three additional members of the section returned to their permanent stations and the logistics officer proceeded to San Francisco to arrange for the disposition of equipment and supplies. Comdr. Cohen remained at Bikini with one half of the original section.

On 25 August, HAVEN departed for Kwajalein where the remainder of the program of target inspection was carried out. By the middle of September, these operations were sufficiently advanced to enable all but two of the Medical Safety Officers to be released from further duty with Task Force One. When it was announced that Test Charlie was postponed, two of the officers who had proceeded to Washington to finish the reports and to plan for the third test, were released to return to their permanent stations, with Lieut. H. Tidwell (HC), USN, remaining as assistant to the head of the section. The work of completing the reports and closing the files of the section was finished during the first week of October.

Concluding Comment

From the standpoint of general safety, the operations of Task Force One were carried out most satisfactorily. Despite the greater hazards of reboarding during Test Baker, there were no accidents which could be ascribed to the test. Excessive radioactivity of the ships slowed inspections and

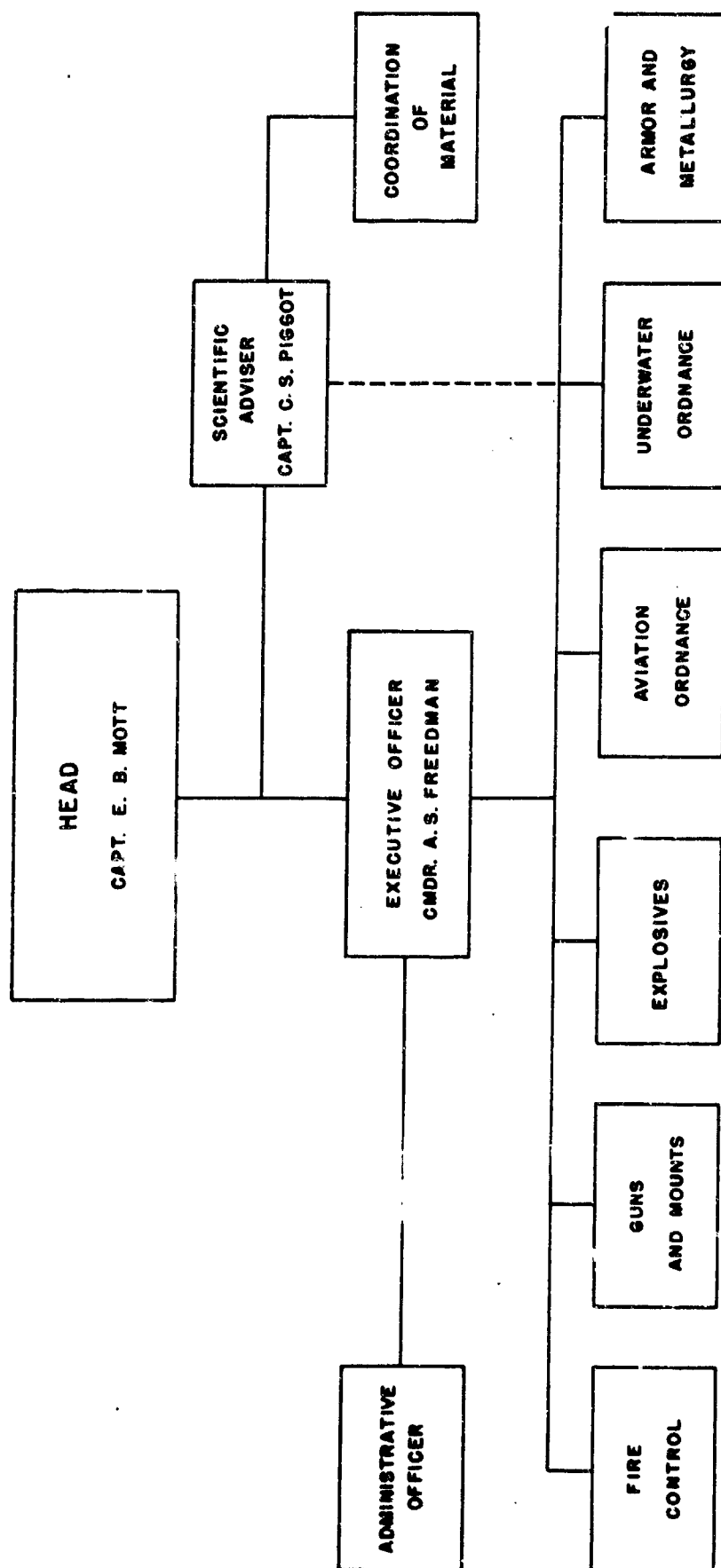
required use of decontamination procedures. When it was found possible to board a target ship for a short time, each compartment had to be tested carefully prior to entry and in some cases rescue breathing apparatus had to be used to enter a space. Visibility below decks was always poor and footing often insecure, owing to loosened, damaged, and wet structure. Furthermore, inspecting personnel often worked many hours under the fatiguing conditions of the tropics, and quite often in haste, so as to avoid radiological overexposure. The fact that no one was injured while working under such unfavorable conditions constitutes a remarkable record when one considers the magnitude of the task and the need for its rapid completion.

Thus the atomic bomb tests gave a valuable demonstration in the efficacy of a carefully planned and executed safety program.

CHAPTER 4

BUREAU OF ORDNANCE GROUP

BUREAU OF ORDNANCE GROUP (O14-L)



BUREAU OF ORDNANCE GROUP

Formation of Group

The Bureau of Ordnance took a leading part in early discussion of atomic bomb tests.¹ After the Task Force organization evolved, Capt. E. B. Mott was assigned on 25 January to the staff of the Director of Ship Material as head of the Bureau of Ordnance Group, which was in charge of material aspects of the ordnance program generally paralleling the instrumentation program.² Captain Mott organized his group with an executive officer, Comdr. A. S. Freedman, Jr., and with six units corresponding to the research sections of the Bureau of Ordnance comprising fire control, guns and mounts, explosives, aviation ordnance, under-water ordnance, and armor and metallurgy. Officers were assigned as heads of these units, and additional personnel performed administrative duties. The decision was made early to appoint Capt. C. S. Piggot, an experienced physicist, as scientific adviser, so that effective technical liaison could be maintained with the work of the Ordnance Instrumentation Group and other related sections of the Task Force. Captain Piggot also took an active interest in the underwater photography connected with the underwater ordnance program.

The concept of the Group organization had been worked out with the Director of the Research Division of the Bureau of Ordnance. Competent personnel were drawn from the Bureau of Ordnance, the Ordnance School, the Naval Gun Factory, and ordnance activities in naval shipyards, with the capabilities of personnel balanced between practical acquaintance with ordnance material and training in research and experimental procedures. The Bureau of Ordnance Group was em-

¹See Introduction: ORIGINS OF ATOMIC BOMB TESTS:
Proposal for Ship Tests with Atomic Bombs.

²See Chapter 10: ORDNANCE INSTRUMENTATION GROUP.

barked in WHARTON with the Director of Ship Material staff.

Responsibility

The general responsibility of the Bureau of Ordnance Group to the Director of Ship Material was to obtain data concerning the effect of an atomic bomb explosion on ordnance equipment and systems, and on the fighting efficiency of ships disposed in the target array at various distances from the blast. This data would be reflected in new designs of ordnance equipment with reference to the extreme effects of heat, blast and radioactivity from atomic bombs. The Bureau of Ordnance Group was specifically responsible, according to the Ship Preparation Plan, for the exposure of material under the cognizance of the Bureau of Ordnance, and with the necessary planning and preparation phases of the work.¹ The Group had a parallel responsibility, under the Reboarding and Inspection Plan, for the inspection of ordnance material.² Through its scientific adviser, the Group was able to furnish technical liaison with other Groups.

The types of ordnance to be included in the tests were limited, in general, to those already installed on the target ships. As most of the ships selected for the tests were scheduled for decommissioning or the inactive fleet, they did not carry the most modern equipment; and the fact that some of the newer equipment had been removed to meet demands of the active fleet decreased the range of data obtainable from the limited distribution of ordnance equipment in the target array. The urgent time schedule did not allow for installation of the most modern equipment, but the older equipment of similar design afforded sound bases for comparisons.

¹See Annex W, App. II: Condition of Target Ships as to Loading of Allowance and Special Ammunition and Explosives.

²See Annex X, App. IV: Bureau of Ordnance Target Ship Inspections.

The various units of the Bureau of Ordnance Group devised standard inspection forms, samples of which were published in the "Red Book"¹ with detailed instructions that would provide for pre-test and post-test comparisons of the operating efficiency of ordnance equipment. These forms were distributed to the target ships, and with the special instructions included in Annex X², furnished workable standards for the inspections and reports.

¹See "Instructions to Target Vessels for Tests and Observations by Ship's Force (BuOrd)".

²See Annex X, App. IV: Bureau of Ordnance Target Ship Inspections.

COORDINATION OF INSTRUMENTATION

Preliminary

The Bureau of Ordnance Group did not possess instruments of its own, and was not responsible for the design, installation, or operation of any instruments, as this responsibility fell upon the Ordnance Instrumentation Group. But instrumentation data had to be available for correlation with damage and for application to changes in ordnance design and operation. For this reason, the Bureau of Ordnance Group, anticipating gamma ray and neutron density and such phenomena as shock, acceleration, static pressure, and temperature, believed a record of these values at ordnance locations would be of primary interest. Accordingly, the scientific adviser, maintaining close liaison with both Ships and Ordnance Instrumentation Groups, made specific requests of these Groups for measurement of blast, acceleration, temperature, and radiation, expressing a preference for time-intensity information over peak readings. The locations included magazines, handling rooms, ammunition hoists, turrets, gun foundations, guns, torpedo tubes, fire control radars, and directors. Detailed lists of locations, with a system of priorities, were submitted to the Ships Instrumentation Group¹ and the Ordnance Instrumentation Group² during the third week in March.

Blast Measurements

Higher priority was assigned to blast measurements in interior than in exterior locations, not only because these are of greater relevance to ordnance material, but because the

¹See Chapter 9: SHIPS INSTRUMENTATION GROUP.

²See Chapter 10: ORDNANCE INSTRUMENTATION GROUP.

Ordnance Instrumentation Group was making ample measurements in free field. This Group agreed to supply the Bureau of Ordnance Group with one hundred foilmeter gauges for measuring peak blast pressure if the latter Group would be responsible for their location and mounting, with some technical assistance. The Bureau of Ordnance Group installed these gauges in one hundred locations on target ships at Terminal Island and Pearl Harbor, and the foil was inserted after the Group arrived at Bikini. The Ordnance Instrumentation Group also made available three Free Piston recording gauges to be installed at internal ordnance locations, where they would give a time-intensity curve. (Actually only one was installed). At the request of the Bureau of Ordnance Group, the Ordnance Instrumentation Group made measurements of shock and blast at five gun shield and turret top locations. These measurements were made by means of four foil gauges and two groups of five ball crusher gauges at each location. The latter gauges were arranged so as to measure blast in all but the downward direction.

Temperature Measurements

The list of temperature locations was compiled in a manner much like the blast list, with preference given to ordnance locations more likely to be affected by temperature change. The Ships Instrumentation Group agreed to furnish temperature paint specimens at all the locations and to make racks of temperature pellets at representative locations on the list. These paints show definite changes of color for each maximum temperature to which they are subjected. Upon arrival at Bikini, the Ordnance Group, to relieve the Ships Instrumentation Section under Commander Langer of the burden of distributing paint to many locations, obtained small metal plates on which the paints were applied. These painted plates were then assigned by the various units of the Ordnance Group to locations involving their type of equipment. By Able Day, approximately 250 such plates and numerous racks of pellets had been distributed among ordnance locations by the Ships Instrumentation Group.

Radioactivity Measurements

The Bureau of Ordnance Group established priorities for measurement of radioactivity largely by considering the number of personnel normally at various ordnance locations. The Radiological Safety Section furnished, and distributed to 300 selected locations, packets containing a casualty film badge, a personnel film badge, a sulphur pellet, and a phosphorous pellet. The personnel and casualty badges measure gamma radiation dosages in low and high range, respectively; and the pellets measure neutron dosages. A supplementary program, involving the design of a lead film pile, was carried out after consultation with the Naval Medical Research Section.¹ This radiation-sensitive film, buried in varying depths of lead, shows degrees of blackening when exposed to radiation. The Bureau of Ordnance Group supplied the lead; and the Naval Medical Research Section made the castings, assembled the piles, and placed twenty-five of the seventy-five at ordnance locations, while remaining responsible for interpreting the results.

Static Pressure Measurements

The Bureau of Ordnance Group submitted to the Ships Instrumentation Group a list of thirty nine desirable locations for installation of static pressure gauges. Commander Langer's section of the Ships Instrumentation Group agreed to install as many of these gauges as could be spared up to forty, and to read and analyze the data; and thirty-four gauges were installed in twenty-six ordnance locations prior to Able Day. These gauges are water-filled glass bulbs which, by means of an air-bubbling passage, record peak pressures by the height of a column of water.

¹See Chapter 7: EXPOSURE OF MATERIAL: Instrumentation

Accelerometer Measurements

Data on the accelerations applied to ordnance equipment, especially directors and mounts, would be important in damage studies by the Bureau of Ordnance Group. As a means of obtaining this data, the Ships Instrumentation Group had the Naval Research Laboratory design a peak-reading accelerometer of the indentor type, which measures acceleration by indenting an aluminum sample with a hardened steel point, the diameter of the indentation being a measure of acceleration. The Naval Torpedo Station, Alexandria, Virginia, built fifty of these gauges, and they were assembled on board WHARTON while enroute to Bikini. Ordnance Group personnel directed the installation of base-plates for these gauges on the target ships at Pearl Harbor and the Ships Instrumentation Group supervised the installation of forty-two of the gauges at Bikini prior to Able Day.

EXPLOSIVES UNIT

Preliminary

The early plans for exposure of explosives on the target ships were drawn up by research sections and sub-sections of the Bureau of Ordnance. The plans provided that a limited number of ships be loaded with the newer developments in munitions and that only a limited number of items of each class of explosive be placed in various target ships, so that the ships would not be endangered by mass detonations. Conferences with representatives of the Army Ground Group resulted in the decision to avoid duplication in similar items by assigning them to one or the other Group¹ which in turn permitted a greater variety of explosives to be tested. When the target array for Test Able had become firm, the Bureau of Ordnance Group decided that the high explosive items, unfuzed, loaded, and plugged, would be exposed in holds, magazines, ready service lockers, and on deck in target ships ranging from the center to periphery of the array; and similarly, other ships were selected to carry special blind loaded and fuzed items. The decision of the Joint Chiefs of Staff in February to include service ammunition, with quantities running from 10 to 100 percent of the war-time allowance, occasioned some change in plans relative to the placement of the special test ammunition, which had to be reassigned to locations other than those occupied by service loads. Later, at Bikini, some reassignment of high explosives was made in an attempt to lessen the danger to target ships carrying important instruments, but an arrangement was maintained for studying the graded effects of distance from the center of the array.

¹See Chapter 6: SUPPORT OF ARMY GROUND GROUP PLAN: Ordnance Unit.

Organization

The Explosives Unit of the Bureau of Ordnance Group was formed to handle the complex problem involved in exposure of the explosives. Personnel of this unit were carefully selected to obtain men trained by war-time experience in the use, maintenance, handling, and overhaul of explosives and ammunition. Comdr. H. C. Dudley was appointed to head this unit. After completing its organization, the Explosives Unit sent representatives to Pearl Harbor, Terminal Island, San Francisco, and Port Chicago, California, to aid in obtaining and shipping to the target ships the service and special ammunition required. These representatives also acted as agents at those stations for all other units of the Ordnance Material Group, with Commander Dudley as Senior Ordnance representative on the West Coast.

ARTEMIS (AKA 21) was designated as the ammunition store ship and was loaded with special Naval and Army ammunition at Port Chicago. ARTEMIS delivered this ammunition to the target ships at Pearl Harbor, and later, at Bikini, acted as a collecting point for the Navy ammunition and fuzes selected for return to the United States for special tests.

Inspections and Tests

Prior to the tests, the Explosives Unit established several measures to promote safety during the inspections. The unit prepared detailed ammunition lay-out plans, which showed the location in each target ship of all Army and Navy ammunition and explosives, as listed in the Ship Preparation Plan.¹ These plans were designed particularly to assist the Initial Boarding Teams and fire-fighting parties in early inspections after both Tests Able and Baker. The unit also installed a special heat-

¹See Annex W, App. II: Condition of Target Ships as to Loading of Allowance and Special Ammunition and Explosives.

test apparatus in AJAX (AR 6) for rapid determination of the safe-life storage period of any questionable smokeless powders. Certain personnel of the Explosives Unit were assigned to AJAX to conduct the usual surveillance tests and to make special examinations of suspected powders.

Following Test Able and again after Test Baker, members of the Explosives Unit were to remove the fuzes from the special fuzed projectiles and ship them to the Naval Ammunition Depot, Fallbrook, California, for analysis and study in the Explosives Investigation Laboratory. Similarly, samples of powder, both of the special supply and of the usual service allowance, and also any items which showed unusual effects, were to be selected and returned to the Naval Powder Factory, Indian Head, Maryland, for detailed study of the effects of radiation.

FIRE CONTROL UNIT

Preliminary

Early in February, sub-sections of the Fire Control Research Section of the Bureau of Ordnance drew up a list of data and measurements relative to fire control equipment desired from the atomic bomb test. The organization established to obtain this data, designated as the Fire Control Unit, under Comdr. Edgar O'Neil, was divided into five sections: Optical, Fire Control (Surface Vessels), Fire Control (Submarines), Fire Control (Radar), and Fire Control (Design). The personnel for all sections, except Design, were officers and chief petty officers with wide experience in the field of fire control equipment. Two civilian engineers recruited from U. S. Naval Shipyard, New York, constituted the fire control design section.

Plans of this unit provided that all types of fire control systems would be energized and operated during the test. Gun Directors¹ of various types, were to be operated on designated ships¹ in order to simulate actual service conditions and to determine the relative susceptibility of injury to operating and non-operating equipment at varying distances from the center of the array. While in Washington, this unit prepared the Fire Control inspection forms which were to be used by the target ships, and also determined the disposition of all fire control equipment damaged in the test.

Optical Section

The Optical Section was organized in February under the direction of Lt. Comdr. C. F. Vance, Ordnance Optical super-

¹See Annex W, Ap.. IV: Condition of Target Ships as to Equipment in Operation.

intendent of the New York Naval Shipyard. This section had cognizance over all ordnance telescopes, periscopes, spotting glasses, rangefinders, binoculars, directorscopes and lead computing sights. Early in March, an officer was sent from this section to the Philadelphia Naval Shipyard, to make a preliminary inspection of the optical equipment in PRINZ EUGEN and two chief petty officers were sent to the West Coast and then to Pearl Harbor to inspect optical equipment on the target ships. These preliminary inspections disclosed the fact that most of the target ships had turned their optical equipment into store and had few or no personnel aboard qualified to make optical inspections. The Optical section obtained the optical equipment for tests and with the assistance of the various naval shipyards made final inspections prior to Test Able. It was arranged that all damaged optical equipment would be returned to New York Naval Shipyard for inspection and study by personnel associated with its design, manufacture, or procurement.

Surface Vessels Section

Shortly after the organization of the Fire Control (Surface Vessel) Section in February, one officer and three chief fire-controlmen went to West Coast shipyards to gain first-hand information on the condition of the fire control systems of various target ships. These representatives also distributed copies of the fire control forms to acquaint target ship personnel with the type of information desired from the test. In March, these same men proceeded to Pearl Harbor to assist that shipyard in preparing the fire control systems of auxiliaries and destroyers. Target ships there lacked sufficient qualified personnel to run the prescribed tests and to inspect equipment in accordance with test instructions. While the necessary personnel were being obtained, section representatives conducted rate control and transmission tests in five target ships and aligned 5"/38 batteries in eleven target destroyers. They also assisted in the installation of 58 pressure

gauges¹ in 18 target ships and the installation of the bases for 37 peak accelerometers² in 13 target ships.

Radar Section

The Radar Research Section of the Bureau of Ordnance first requested the Assistant for Electronics (ECO) to obtain information on Fire Control Radar equipment in the Bikini test, but it soon became apparent that the Electronics Group would be unable to give sufficient attention to Fire Control Radar because of the enormous amount of other electronics equipment installed in the target vessels. Accordingly, an officer, obtained from the Naval Research Laboratories, reported to the Fire Control Unit to head its Radar section. Conferences with the Electronics Group delegated cognizance of antennae assemblies, antenna alignments and operational checks of fire control radar equipment in operating target ships to the Ordnance section, with divided cognizance in regard to radar equipment in non-operating target ships. Later at Bikini, the Electronics Group assumed cognizance of all electronic portions of fire control radar equipment. In March, a member of the radar unit went to the West Coast to arrange for disposition of certain items of radar test equipment, and during April, other members of the unit made inspections of all fire control radar equipment installed in target vessels at Pearl Harbor. Further inspections were made at Bikini, as well as numerous radar calibrations both on radar beacons set up on charted shore locations and operated by unit members and also on helicopters and aircraft. Civilian engineers joined the section there to assist in the assessment of the data.

^{1,2}See this Chapter: COORDINATION OF INSTRUMENTATION:
Blast Measurements. Accelerometer Measurements.

Submarine Section

In early March, the Ordnance Group requested the services of an officer to supervise preparation and inspection of ordnance equipment in submarines. After reporting to the Fire Control Unit in Washington, this officer proceeded to Pearl Harbor, arriving there 25 March, and joined the Crossroads submarine representatives to assist in conditioning the submarines for the test. Five of the eight target submarines had ordnance fire control equipment which was of special interest to this section and which required thorough alignment and inspection. The overall fire control plan provided that PARCHE was to have its fire control equipment energized during both tests. Firecontrolmen of FULTON assisted in preparation of ordnance equipment in the submarines both at Pearl Harbor and at Bikini.

GUNS AND MOUNTS UNIT

Preliminary

The Bureau of Ordnance plans for the atomic bomb test required an evaluation of the change in military effectiveness of turrets, gun mounts, and machine guns exposed to an atomic bomb detonation. This broad requirement demanded that guns and mounts be displayed in both operating and static condition and that the design of the physical distribution cover the range of possible damage from maximum to minimum. In accordance with the Ship Preparation Plan,¹ 5" mounts on SARATOGA and four destroyers, and 40 MM mounts on PENSACOLA, three of the same destroyers, and four auxiliaries were to be energized during Test Able. The variety of conditions prescribed for the turrets and mounts included some in condition "Y" and some in condition "Z", some with gun breeches open and in other cases closed, and some with primers inserted in the firing locks. Angles of train and elevation were varied to obtain comparative structural reactions. For specific installations, the Instrumentation Group required angles of train and elevation in the direction of the anticipated center of the explosion to expose test panels secured on the mount shields and cameras mounted in gun muzzles. Certain mounts and turrets contained ammunition to simulate battle conditions, others were clear of ammunition to simulate normal operation. Special hydraulic oil placed in the speed gear assemblies of representative non-operating mounts furnished a basis for test of its special qualities of non-inflammability.

¹See Annex W, App. IV: Condition of Target Ships as to Equipment in Operation.

Organization

A Mobile Turret Unit was the nucleus of the Guns and Mounts Unit formed in February 1946 to carry out this phase of the Ordnance program. The Executive Officer of the Bureau of Ordnance Group originally served as head of the Unit, but to provide more time for his executive duties he was replaced by an officer from the Guns and Mounts Design section of the Bureau of Ordnance, Comdr. F. W. Russe. A civilian engineer from the Naval Gun Factory joined the Unit as Guns and Mounts technician and a civilian engineer from the Maintenance Division of the Bureau of Ordnance served as metallurgist. One of the Mobile Turret Unit officers directed the work on heavy caliber guns and mounts and the Philadelphia Naval Shipyard furnished an officer to head the light caliber guns and mounts group.

Preparations

Preliminary ground work in Washington included preparation and dissemination of instructions to the Naval Shipyards and to the ships themselves for conditioning the guns and mounts. Conditions under which the mounts were to meet the test were worked out in close accord with the Bureau of Ships Organization as regards structural features, with the Explosives Unit in connection with simulated service conditions and the presence and location of ammunition, and with the Fire Control Unit as regards mounts in operation. The Unit later developed the preliminary instructions into the forms, which were included in the "Red Book", for uniform comparative evaluation of the equipment. Before leaving Washington, personnel at nearby ordnance activities assisted the Unit in assembling numerous tools and instruments, including special devices such as bore gauges and hydraulic pressure gauges, not normally available outside a navy yard, and collecting a reference library of ordnance pamphlets and data sheets.

Pre-Test Inspections

The Mobile Turret Unit went to Pearl Harbor several weeks in advance of the remainder of the organization to assist in the general preparation of the target ships. In numerous cases, the condition of turrets and mounts required special checks to establish normal operation. For an example, the main battery of NEW YORK, which had not been fired since regunning, occasioned detailed examination with emphasis on gun alignment; again, a gun mount on one target ship, deprived of power by decommissioning of the ship prior to its assignment to the target group, required replacement of cables and rematching of instruments. Mounts on several target ships operated erratically in both automatic and local control. While correcting these and other similar operational abnormalities, the unit assisted the Instrumentation Group in location on turrets and mounts of numerous physical measuring instruments and many small metal plates striped with temperature paint.

AVIATION ORDNANCE UNIT


Preliminary

The Aviation Ordnance Research Section of the Bureau of Ordnance, considering the types and disposition of aircraft in the target array as determined by the Bureau of Aeronautics,¹ suggested the aviation fire control equipment to be installed for the test. The aircraft were to be in a state of combat readiness and contain the ordnance equipment normally installed, such as bomb shackles and racks, gun sights and machine guns. Additional test materials, consisting of bombs, rockets, machine gun ammunition, bomb directors and bomb sights, were installed in the types of planes usually employing that type of equipment. The bombs and rockets loaded aboard the planes were to be blind loaded and fuzed, and machine gun ammunition was to be limited to 10 rounds per gun. Items selected for exposure were given wider distribution in SARA-TOGA as compared with that placed aboard INDEPENDENCE because of the belief that aircraft on the latter would be demolished.

Organization and Inspections

The Naval Ordnance Test Station, Inyokern, California, furnished a gunnery officer to head the Aviation Ordnance Unit and maintain liaison with the Bureau of Aeronautics Group. This liaison duty consisted of collaboration with the Aeronautics Group in the procurement and installation of special aviation ordnance equipment. In the middle of March, the head of the Unit accompanied members of the Bureau of Aeronautics Group to Alameda, California, for inspection of aircraft and ordnance equipment to be used as target material.

¹ See Chapter 5: SHIP PREPARATION PLAN: Target Aircraft.



Arrangements were made with Carrier Aircraft Service Unit No. 6 and with the Assembly and Repair Department, Alameda Air Station, for receipt and installation, under the supervision of a Bureau of Ordnance representative, of aviation ordnance fire control equipment procured for aircraft in SARATOGA. Later in March, the Unit inspected equipment installed in observation aircraft on the target ships being prepared at Terminal Island. Preparation of the aircraft on auxiliaries was performed by Bureau of Aeronautics representatives at Pearl Harbor and inspection of this equipment was deferred until the Unit arrived at Bikini. Aviation fire control equipment damaged in the test was to be returned to the Naval Ordnance Plant, Indianapolis, Indiana, for detailed examination. Bomb and rocket fuzes were to be returned to Naval Ammunition Depot, Fallbrook, California.

UNDERWATER ORDNANCE UNIT

Preliminary

Although official participation of the Bureau of Ordnance Group in Operation Crossroads began in January 1946, planning of the underwater phases may be said to have started in December 1945, when the cognizant research section discussed tentative underwater ordnance programs with representatives of the Naval Ordnance Laboratory and the Naval Torpedo Station. At the same time, the section considered probable assignments of qualified personnel to the proposed Task Force. Original plans assumed that explosives and combustibles would be present only in token quantities but the approved Ship Preparation Plan¹ called for loading of from 10 to 100 percent of normal allowance. Commander Joint Task Force One rejected early proposals that four special net sections be placed in the target array and that a moored mine field be laid in the target area. He also decided against proposals that six explosive warheads and six torpedoes with inert heads be suspended from buoys at normal running depths and that warheads containing different types of explosives be exposed on the decks of the target ships. Approved plans provided that mines of a type representative of all U. S. Navy mines be placed on the open deck of certain vessels and that various types of depth charges be placed on target destroyers at varying distances from the burst. The loads of mines and charges would be inert but all mechanisms, detonators, and boosters would be in place. A Bureau of Ordnance recommendation approved in February, prohibited the use of torpex-loaded warheads, but later decision permitted the use of torpedoes which were equipped with service warheads and dummy exploders.

¹See Annex W: App. II: Condition of Target Ships as to Loading of Allowance and Special Ammunitions and Explosives.

Primary Planning

Officers from the Underwater Ordnance Research Section prepared the preliminary instructions for the test and in February, one of these officers, Lt. Comdr. H. M. Tatum, organized the Unit which was to conduct preparations. The organization consisted of six sections comprising submarine torpedoes, special torpedoes and weapons, destroyer torpedoes, mines and depth charges, ordnance disposal, and underwater photography. War-time experiences in the use and handling of explosives governed selection of the officers who took charge of these sections.

After the Unit organization evolved, the group gave primary consideration to procurement of materials for the test. The first plan was to supply all torpedoes and associated equipment from supply centers in continental United States, most of which were located on the East Coast. The Unit later decided that the Pearl Harbor area had a sufficient backlog of torpedoes to provide those required for the test and requested the Commander in Chief, Pacific Fleet, to make the material available. Supply orders issued in the latter part of February directed the Naval Mine Depot, Yorktown, Virginia, Naval Ammunition Depot, Hawthorne, Nevada, Naval Torpedo Station, Keyport, Washington, and Naval Air Station, Alameda, California, to ship additional test materials to the Pearl Harbor area. The orders also required the Ammunition Depot at Hawthorne to ship warheads to Yorktown for inert loading.

Modification of Plans

With a view toward future development in underwater weapons, the Underwater Ordnance Unit compiled a list of types, quantities, and test conditions of specially prepared "Research" torpedoes and underwater weapons, which were proposed for loading in the target ships. The list also covered the exposed types and quantities of auxiliary explosive components such as detonators and impulse charges. When the

overhaul and preparation of 480 service torpedoes emerged as a task almost prohibitive for the personnel, facilities, and time available. the Bureau of Ordnance proposed that the use of "Research" torpedoes be accentuated. Acceptance of this proposal not only minimized the overhaul task but also afforded the opportunity for extensive tests on newly designed torpedoes and weapons as well as special modification on some service torpedoes. Early in March, the Unit promulgated instructions for the preparation of "Research" torpedoes for the SARATOGA and INDEPENDENCE.

Preparation of Weapons

Late in February, two officers, directing preparations of submarine and destroyer torpedoes, together with enlisted personnel, reported on FULTON at Pearl Harbor and immediately commenced assembly and loading of the special and modified service torpedoes. Later, the group supervising preparations of destroyer torpedoes reported to and operated from DIXIE. A pamphlet, prepared and previously distributed to the field groups by the research section of the Bureau of Ordnance, governed the preparation and loading of all torpedoes. Some of the conditions of loading are set forth in the following paragraphs.

For submarines, there was to be an even distribution with respect to mark and modification of all special test torpedoes. In order to determine the result of direct exposure of a torpedo and its tube to the effects of the explosion, the muzzle door of one loaded stern tube was left open on each of two submarines, later designated as APOGON and DENTUDA. Air leads were to be capped to preclude any possibility of the torpedoes starting a run and various compartments of the torpedo were to be filled with different colored liquids for ready detection of leaks. Unit cell batteries in torpedoes had no electrolyte in order to eliminate the possibility of hydrogen explosions within the tubes.

Specifications for destroyers provided that the service allowance torpedoes be equipped with live warheads and dummy

exploders. The special torpedoes were to be distributed in ships having a low percentage of the normal allowance of regular service torpedoes. Tubes containing service torpedoes would be scuttled in the event of breakage of a tripping link, while the mounts containing the special test torpedoes were trained to the stowed position. Firing hammers were to be placed in various conditions of readiness with detonators, boosters, and impulse charges placed to test their behavior under normal stowage conditions.

Instructions specified that aircraft torpedoes placed in normal aircraft carrier stowages have flasks charged. Torpedoes placed in aircraft were to have uncharged flasks. All special test torpedoes and special weapons contained inert warheads with live exploder mechanisms.

Underwater Photography Section

The Ordnance Material Group assigned to its scientific advisor the task of planning, organizing and directing the Underwater Photography Section. Although this section was attached to the Underwater Ordnance Unit and was thus shown on organization charts, the basic plan contemplated that the group would make extensive underwater photographs of all damaged target ships and materials sunk in the Lagoon during the test which could not be easily salvaged. The section was not confronted with problems of preparing and exposing underwater ordnance equipment or test materials but special requirements of the task called for considerable advance planning. The underwater cameras and associated equipment had to be operated by qualified divers also skilled in underwater photography. Since the water of Bikini Lagoon exceeds depths of 150 feet in many places, the divers had to be familiar with the operation of deep sea diving gear as well as the more common shallow water equipment. In order to qualify men for this duty, the section had to obtain volunteers with experience in surface photography and school them in diving and underwater photography. After the necessary boats, pumps, diving and photographic equipment arrived at the scene of operations,

the section practiced frequent rehearsal dives to familiarize members with the actual diving and photographic conditions in Bikini Lagoon.

Underwater Photographic Equipment

The equipment and procedures developed by the Mine Disposal Service were provided for the Underwater Photography Section. Although most of this equipment was intended for operation at depths less than those in Bikini, it was believed that excellent pictures could be made in the clear water and with the bright sunlight generally in that area. Also, the need for supplementary sources of artificial light could be determined and the light supplied as required. Mark 5 cameras, designed by the Bureau of Ordnance, and the more elaborate Mark 7 cameras, developed from the wide angle Fairchild aerial camera, were the basic photographic equipment. While the latter is bulky and difficult to handle, a curved glass surface covering the lens takes advantage of the index of refraction of seawater to afford greater field of view. To determine underwater light conditions, the section used a hydrophotometer. This instrument consists of a uniform light source separated from a photo-voltaic cell by 100 cm of seawater. Light energy from the source impinging on the sensitive layers of the cell develops an electromotive force which deflects a galvanometer connected to the cell. Since the light source is constant, the scale reading of the galvanometer is a function of the light absorbing properties of the seawater surrounding the hydrophotometer.

ARMOR AND METALLURGY UNIT

Preliminary

After several conferences held during December 1945, and January 1946, the Ordnance Group decided that the effect of the atomic bomb explosion on armor could best be determined by exposing sample armor plates of known ballistic, chemical, and metallurgical properties at varying distances from the point of detonation. Accordingly, the Naval Proving Ground, Dahlgren, Virginia, was requested, in early February, to supply three sets of armor plates and armor samples of known properties representing current manufacture of all types and gauges. Location of ships in the target array, deck strength of ships at desired locations, and shipyard availability of the ships selected were major considerations in determining the placement of the test samples for exposure; and once the size and weight of these materials were known, space assignments were chosen on NEVADA, PENSACOLA, SALT LAKE CITY, and ARKANSAS. Later, when it was apparent that the removal of armor plates, having thicknesses of 6 inches and over, from the target ships at Bikini would be impracticable because of limited lifting facilities, the decision was reached to cancel two plates each of the heavy gauges. For purposes of comparison, a 3' x 3' sample plate was cut from each plate allocated for the air burst test and made available for exposure during the underwater burst.

Preparation and Installation of Armor

One officer and one civilian armor technician reported to the Ordnance Material Group in February to carry out the armor testing program. Early in March, the armor technician proceeded to Terminal Island to supervise the cutting and installation of the armor plates which had been shipped to that shipyard. Plans specified that six samples be cut from each

of the heavy gauges plates (3 for Test Able and 3 for Test Baker) and the remaining portions of each plate, size 18' x 18', were to be installed aboard NEVADA.

The Design Section at Terminal Island assisted the armor technician in devising methods for securing the armor plates and samples aboard the target ships. The design which evolved after consideration of the anticipated shock wave, the possible fusion of plate to securing gear, and desirability of easy removal of the samples, consisted of steel corner supports welded to the decks with heavy holding-down clips separated from the plates by wood and asbestos fillers. The corner supports and holding-down clips were located according to the plan for exposure and the plates and samples were installed on the target ships late in March. The weight of the four large plates installed on NEVADA occasioned shoring of the area under the plates for two deck levels to provide adequate shock resistance. The armor technician also arranged with the Terminal Island Naval Shipyard to furnish and ship to Bikini, corner-pieces, clips, welding rods and gas-cutting facilities to be used in preparation of armor installations for Test Baker.

Inspections and Tests

Photographs of each plate and sample, taken to show the condition of the armor, securing gear, and the armor structure, formed part of the pre-test permanent record. Visual inspections by the armor technicians and the Group metallurgist at Pearl Harbor and again at Bikini, with results recorded in the special armor forms, included in the "Red Book", completed the record. The finished forms showed the plate number, its location aboard ship, the condition of top surface, its proximity to adjacent shielding structures and to other samples and equipment, the proximity of instruments and explosives, and the type of deck and shoring. A similar photographic and inspection record made after the tests would provide the basis for damage analysis of the special armor. Although data obtainable from the Instrumentation Groups would be adequate for blast and shock measurements, the Unit marked the armor

samples with temperature paint to assure all possible information.

Because Technical Missions to Japan and Germany obtained information concerning manufacture and treatment of armor, the Unit did not obtain special pre-test samples from PRINZ EUGEN, NAGATO, and SAKAWA. As the ship's force of each ship had recorded the condition of the ship's armor structure on Armor Unit forms, samples were to be removed and photographs taken only in case ship's armor was damaged.

The special armor, together with plates or samples cut from damaged ship's armor structures, were to be returned to the Armor and Plate Laboratory, Naval Proving Grounds, Dahlgren, Virginia, for extensive metallurgical and ballistic tests. The large plates on NEVADA were to be returned to the Naval Proving Grounds upon the completion of both tests when NEVADA returned to a Naval shipyard having adequate facilities for lifting.

TEST OPERATIONS

Test Activities at Bikini

Crossroads representatives of the Bureau of Ordnance Material Group assigned to preparatory work in naval shipyards boarded WHARTON at the same time as did representatives from other Groups. The Ordnance Group, fully assembled for the first time at Pearl Harbor, held several conferences with gunnery officers of target ships to insure that all instructions were clear and to outline the work yet to be done at Bikini. Enroute to Bikini, the various Units assigned the teams which were to perform the pre-test and post-test inspections. The principal work after arrival at Bikini was to check off the detailed completion of the inspection forms which had been distributed to the target ships.¹ There were some additional preparation tasks such as the installation of accelerometer gauges and temperature paint plates and the completion of the photographic record. The Armor and Metallurgy Unit checked the placement of armor samples and stamped the samples with identifying marks. The Guns and Mounts Unit, apart from checking operation of their installations, took Brinell hardness readings on turret guns of NAGATO and placed special hydraulic oil in mounts on four combatant ships. The Fire Control Unit sent out two inspection teams which, while checking readiness of fire control equipment on target ships, assisted in radar calibrations conducted on observation planes and helicopters. The Explosives Unit shifted a number of high explosives which had been reassigned by agreement with the Instrumentation Unit to lessen the danger to nearby instruments. This Unit also removed, by direction of the Task Force Commander, warheads from thirty-two service torpedoes on SARATOGA and placed them in the regular warhead storages on that ship. The Underwater Ordnance Unit, while rigging mines and depth charges on various ships, removed

¹See this Chapter: BUREAU OF ORDNANCE GROUP: Responsibility.

detonators and boosters from loaded charges and installed same on blind-loaded charges. The Underwater Photography Unit practiced numerous deep dives both to train personnel in diving and to obtain experience in use of underwater cameras.

Test Able Operations

Officers of the Ordnance Material Group, accompanied by enlisted torpedomen and minemen, participated in the Queen Day rehearsal and the actual test on Able Day as Bomb Disposal and Ammunition Safety Officers on each of the Initial Boarding Teams.¹ On completion of re-boarding, which occurred without incident, these members rejoined their Units to assist in technical inspections. Little damage occurred to ordnance equipment except on ships which received major structural damage and the technical inspections of the Group proceeded rapidly. The Gross Damage Report, based on data gathered from preliminary inspections, was submitted to the Director of Ship Material on 6 July. Lack of facilities for handling heavy equipment prevented removal of large armor samples from the target ships and only the small armor plates were returned to the United States immediately after Test Able. On 17 July, all Units reported technical inspection completed and Ordnance preparations fully ready for Test Baker. The Group then concentrated on preparation of Interim Report for Test Able which was submitted on 30 July.

Test Baker Operations

Representatives of the Ordnance Material Group participated in similar capacity on the Initial Boarding Teams for Test Baker. Although these teams were disbanded soon after

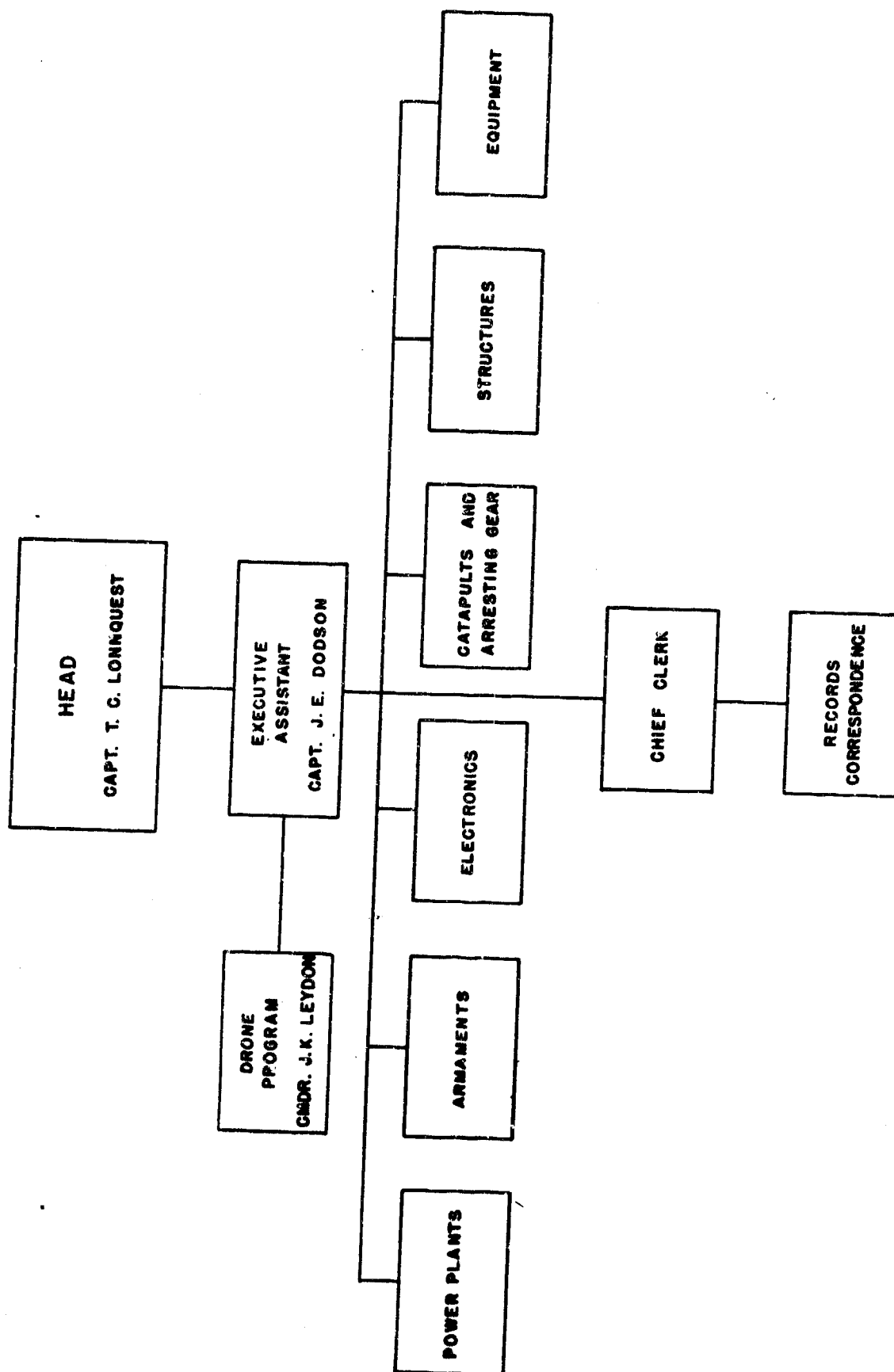
¹See Chapter 1: OPERATIONS DURING TEST ABLE: Dispersal of Staff.

the test due to the re-boarding delays previously mentioned, officers of the Group continued to operate with the decontamination units as ammunition safety officers. Ordnance technical inspection teams completed examination of ordnance equipment on the five auxiliaries initially cleared, plus WAINWRIGHT and CONYNGHAM, by 3 August, but were restrained, as were other teams, from general reboarding and inspections. Preliminary inspections of accessible target ships provided little information available for the Gross Damage Report submitted on 6 August. As decontamination processes cleared the target ships, Ordnance teams joined with other groups to conduct their inspections. All Ordnance technical inspections were completed by 25 August, and the Group submitted, on the following day, its section of the Interim Report which showed detailed assessments of damage sustained by ordnance equipment. After completion of operations at Bikini, and upon return to United States, many members of the Group were released through demobilization, reassignment, and return to permanent duty stations. Other members of the Group re-assembled in Washington for preparation and completion, under the supervision of Unit heads, of all Ordnance Material Group technical reports.

CHAPTER 5

BUREAU OF AERONAUTICS GROUP

BUREAU OF AERONAUTICS GROUP (014-J)



BUREAU OF AERONAUTICS GROUP

Formation of Group

Formal participation of the Bureau of Aeronautics in Operation Crossroads began on 21 January 1946, when Captain T. C. Lonnquest was relieved of his duties as Director of Engineering in that Bureau and ordered to report to the Commander Joint Task Force One for temporary duty on his staff as Bureau of Aeronautics liaison officer for naval aviation material. As the Joint Task Force organization finally developed, the Bureau of Aeronautics Group came under the Director of Ship Material. The Group comprised a head, a technical staff, and a rear echelon. The technical staff represented the six main categories of aeronautical material: power plant, armaments, electronics, structures, equipment, catapults and arresting gear. The rear echelon was made responsible for radio-controlled pilotless aircraft and related equipment. The armaments phases were developed in liaison with the Bureau of Ordnance Group. The airborne electronics program was accomplished under the Electronics Group by personnel detached from the Airborne Coordinating Group of the Naval Research Laboratory to serve with that group.

Responsibility

The general responsibility of the Bureau of Aeronautics Group to the Director of Ship Material was to plan and implement the program for exposure of naval aviation material, to make inspections and technical reports, and to furnish liaison with other groups. Specifically, the Group supported the Direc-

tor of Ship Material's Ship Preparation Plan¹ and Reboarding and Inspection Plan.² The routine activities of the Bureau of Aeronautics involved the group in material support of various phases of the Operation Plan. The use of Navy drones in Operation Crossroads required that the Group carry out a major development and manufacturing program, which is described at length, as it goes beyond the routine activities of the Bureau.

¹See Annex W, App. III: Condition of Target Ships as to Aircraft Loading.

²See Annex X, App. V: Bureau of Aeronautics Target Ship Inspection.

OPERATIONAL PLANS

Routine Activities

The logistic support which the Bureau of Aeronautics Group provided for various phases of the Operation Plan involved, except for the drone program, a mere intensification of routine naval aviation activities. Naval air stations, especially those at Atlantic City, Norfolk, San Diego, Alameda, and Pearl Harbor, as well as other field activities, felt the impact of Operation Crossroads in the form of calls for increased support. Various air stations and aircraft delivery units accomplished high priority programs in the preparation and delivery of target aircraft.

Transport and Air-Sea Rescue

There was considerable increase in the demands upon the Naval Air Transport Service, along with the Army Transport Command, for continental and overseas air lift, as provided for in Logistics Plan.¹ Seaplanes of transport squadron VPB-32 and air-sea rescue squadron VH-4 were based on Ebeye, according to Logistics Plan and Air Plan.² The PBM aircraft of VPB-32 provided inter-island air transport between Kwajalein, Roi, and Bikini. Turn-around and fueling service for this unit came from the seaplane tender ORCA (AVP-49). VPB-32 also furnished three seaplanes for photographing the water wave travel,³ and one seaplane of the unit carried out radiological reconnaissance in support of the

¹See Annex B: Logistics Plan.

²See Annex F: Air Plan.

³See Annex L: App. II: Wave Measurement Flight Plan.

Safety Plan.¹ The participation of the Bureau of Aeronautics Group in preparing the seaplane is cited as an example of material support given the Instrumentation Plan.

At the end of March, the Ordnance Instrumentation Group informed the Task Force that provisions for the installation of thermo-radiation equipment, called a bolometer, in an aircraft was necessary for Test Baker.³ The Bureau of Aeronautics thereupon procured a PBM-5 seaplane and had the equipment mocked-up at the Naval Air Material Center in Philadelphia. Plans for the installation were made. At this time plans called for VPB-32, based at Ebeye for the tests, to make the installation there between Tests Able and Baker, but upon postponement of the tests the Bureau of Aeronautics arranged that the installation be made under more favorable conditions at the naval air station at Kaneohe Bay.

The group furnished logistic, material, and technical support to VH-4, which also operated PBM-5 seaplanes in providing facilities described in the Air-Sea Rescue Plan.⁴

Photographic Aircraft

Naval photographic aircraft were made available to the carrier SAIDOR, focal point for aviation photographic activities, as provided in the Photographic Plan.⁵ Six F6F-5P aircraft, equipped for any type of vertical photography as well as trimetrogon photography, were needed to photograph the

¹See Annex E, App. II: Radiological Safety Plan, Test Able.

³See Chapter 10: RADIOMETRY INSTRUMENTATION: Unfocused Bolometers.

⁴See Annex Y: Air-Sea Rescue Plan.

⁵See Annex L: Photographic Plan.

target area before and after the blast, and to provide precise mapping of the target array. Four TBM-3 aircraft were allotted for providing oblique photographs of general interest for history and press releases, including pictures of the target area, progress of bomb blast and cloud formation, and damaged target vessels. SAIDOR also planned to use four helicopters, HOS-1 (Army R-6), for general utility in rushing photographs taken by the TBM-3 photographic planes to APPALACHIAN for release to the press. SAIDOR aircraft had to be provided with kits for installation of Geiger counters and milliammeter galvanometers to warn pilots of zones of radioactive contamination. Only the radioactivity warning device and the drone program required more than a mere intensification of the Bureau's routine activities. Apart from carrier-based aircraft, three PBM-5 patrol bombers were to be stationed at various altitudes for photographing the water wave travel in stereo after the bomb blast to determine water wave form, rate of travel, height, and other phenomena.

DRONE PROGRAM

Exploratory Discussions

The preparation and furnishing of drones, control planes, and related technical equipment required a major development and manufacturing program.

At a meeting of the Technical Staff of Joint Task Force One, on 17 January, Los Alamos representatives discussed the use of radio-controlled aircraft to obtain radioactive samples in the explosion area, explaining the importance of these samples and the radioactive conditions to be expected. Captain Lonnquest and Commander Leydon had already given to the Deputy Task Force Commander for Technical Direction, Admiral Parsons, a brief resume of the capabilities of Navy radio-controlled aircraft. The usefulness of these aircraft in collecting radioactive samples had been appreciated because of the tentative decision of the Radiological Safety Section that it would not be safe for manned aircraft to enter the radioactive area.

Admiral Parsons reviewed these matters in detail at a later meeting the same day with the Deputy Task Force Commander for Aviation and representatives of the Bureau of Aeronautics Group and the Air Technical Service Command. The Army Air Force representatives, surveying their material available for sampling, proposed the use of B-17 drones, with filters installed, which would take off and fly under radio control and make crash landings, or, if the technique were developed in time, landings under radio control. The Navy representatives proposed the use of F6F drones, a modified combat type already perfected for full radio control in take-off, flight, and landing, as these aircraft could be launched by catapult from a carrier near the scene of the drop and flown to an island base upon completion of their mission. The technical staff decided that the F6F drones, currently employed in operating squadrons, would come closer to guaranteeing safe recovery of the sampling apparatus than the B-17 drones, which were given the task of going into the radioactive area

Operational Assignment

At a conference on 21 January, attended by members of the technical staff and representatives of the Bureau of Aeronautics Group and of the Deputy Chiefs of Naval Operations for Air and for Operations, the Navy drone operation was assigned to Experimental Utility Squadron Twenty-Five, based at Atlantic City, N.J. This squadron, currently operative, was based near the Naval Aircraft Modification Unit, at Johnsville, Pa., which had underway an extensive drone conversion program, making it a convenient source of technical information regarding the material aspects of the task. The Commander of the Operational Development Force, under whom this squadron operated, detailed the Air Projects Officer of his staff, Captain J. W. Davison, to take command of the unit and prepare for Operation Crossroads.

Until the required number of drone and control planes had been established, it was thought the the drone unit could operate from the same carrier as the photographic unit. But as the separate projects grew in size there seemed little chance of success for either if they were crowded aboard a single carrier. Accordingly, SHANGRI-LA was designated the sole base of the drone unit, making possible the use of extra planes for practice operations and spares.

Manufacturing Program

After the preliminary decisions by the technical staff, the Bureau of Aeronautics established projects, on 22 January, at the Naval Aircraft Modification Unit, Johnsville, Pa., calling for accelerated production at highest priority of twenty F6F 3K drones and twenty F6F-5 control planes. On 1 March, this program was increased to twenty-six drones and thirty control planes. Following the postponement, four more drones were prepared and held in reserve.

The choice of a fighter type as control plane for the drones had been made because the technical staff desired that the

drones fly through radioactive area at high altitude. Since the control planes, though remaining at a safe distance, must have performance comparable to that of the drones, it was not considered possible to use multiplace scout or torpedo bomber types as control planes.

Radio-Control Problems

It was difficult to obtain large amounts of radio-control equipment because of unsettled labor conditions in manufacturing plants, but enough equipment was obtained at the outset to enable the drone unit to begin training for the operation. Tests were initiated at the Naval Air Material Center, at Philadelphia, to determine the capability of the drone control equipment to withstand catapulting. These tests established the complete suitability of the F6F drone for its assigned task. In the meantime, personnel experienced in radio control were gathering at the Naval Air Station, Atlantic City, N. J., from continental and outlying bases. Many experienced radio control pilots had to be given training in carrier operations, something new for nearly all of them.

Radioactivity Filters and Geiger Counters

Early in February, progress was made in clarifying many technical questions regarding the type of radioactivity filter for the drone and the type of safety equipment for the control planes, such as goggles and Geiger counters for pilots. The Geiger counter posed a problem. It had been assumed in earlier stages of planning that multiplace aircraft could be used as control planes, with a radiological expert aboard to provide a running determination of ambient hazards. The question of the ability of a control plane pilot, flying alone in a single-seat aircraft, to listen to signals of a counter while operating his own plane and controlling a drone, finally was affirmed. The remaining safety problem was to determine whether the Geiger counter would stand up, operate successfully, and provide a positive indication to the pilot.

Additional Information

The Bureau of Aeronautics conducted a detailed study of its drone equipment to find out what additional instrumentation could be included in the drones. Since it was necessary to restrict the number of radio links between the drones and control planes to those already in use, there seemed no possibility of installing any instrumentation which required a repeat back link. But it was found possible, despite limitations of space and electric power, to accommodate the VGTA recorder, which measures velocity, acceleration, time and altitude; and during the month of February, eight planes of the drone unit were modified for the installation of this instrument. The four drone planes for flying through the radioactive area had the instruments installed, and the other four, held in reserve, had provisions for the installation.

The Photography Group of the Task Force, which had made an early request for installation of photographic equipment in the drones, clarified their requirements late in February to include installation of 16-mm gun cameras in the first four drones and a 35-mm Mitchel camera in the wing bombrack of one of the four. These cameras were modified to require only a starting impulse, and the radio-controlled circuits were ingeniously arranged so that the starting impulse for the VGTA recorders and the cameras were tied together with the control channel for the drone brakes, which would not be used during flight.

Design and Testing of Radioactivity Filters

During the middle of February, the Bureau of Aeronautics and the Air Technical Service Command at Wright Field maintained close liaison on the designs required for proper performance of the paper filter which was to collect radiological data. A preliminary model incorporating the best ideas of both services was made up at Wright Field and tested in the Wright

Field five-foot tunnel. By 19 February, this design had been approved, and the Bureau of Aeronautics started arrangements for manufacture of all units for the Navy drone group. The Army-Navy design was tested in the wind tunnel at the David Taylor Model Basin at Carderock, Maryland, where it underwent slight modifications to give increased performance. On 1 March, production of twelve units started at the Naval Aircraft Factory, Philadelphia, and two weeks later the units were delivered to SHANGRI-LA in Norfolk. By this time, word had come from the Los Alamos group that the filter design must incorporate a feature which would allow quick removal of the filter paper from the unit at distances of six to ten feet. Immediate steps were taken to design such provisions into the unit, and the modification parts were flown to SHANGRI-LA in San Diego for installation. Provisions were also made to allow removal of the filters, attached to the drone bombracks, from a safe distance, and to allow removal of the filters from the vicinity of the drone prior to withdrawal of the filter paper.

Design and Testing of Geiger Counters

The first model of the Geiger counter for the control planes became available to the Navy on 15 March at the Victoreen Instrument Company, in Cleveland. After the counter had been flown to Philadelphia and installed in an F6F-5 plane, the plane was catapulted, flown, and landed to determine the test performance of the counter. These tests revealed that the audio indication which the counter gave was unsatisfactory because of the low audibility of the signal compared with cockpit noise. Modification of the counter substituted a visual indication to the pilot from a micro-ammeter on the instrument panel of the control plane. When all attempts to amplify the audio signal of the counter had proved fruitless, a decision was obtained from the Radiological Safety Section to allow complete dependence by the pilot upon his visual indicator. Necessary material to modify the original audio types was delivered to SHANGRI-LA in San Diego.

Operational Training

Postponement of the tests afforded more time for operational training of the drone unit, both aboard SHANGRI-LA and ashore at the Naval Air Auxiliary Field, Chula Vista, California. Meanwhile, the Chief of Naval operations had changed the designation of Experimental Utility Squadron Twenty-Five to Experimental Squadron Two, and the drone unit designation became the VX-2 detachment, its standard designation apart from its numerical assignment as part of a Task Unit in the Operation Plan.

The unit commenced modifying its radioactivity filters and Geiger counters during the first week of April. Training flights over the Almagordo site in New Mexico were made during the third week in April to test the operation of the Geiger counters and to train control pilots in both the use of the visual modification developed in March and the sensitivity switch now incorporated in the counter.

Collection of Water Samples

On 2 April the technical staff of the Task Force had a conference to discuss a request by the Los Alamos group for use of radio-controlled boats to take water samples and make radiological surveys of Bikini Lagoon after the tests. Previous to this time, it had been planned that the helicopter unit would take water samples and obtain low-altitude radiological safety data.¹ The hazards in operating the helicopters over the "hot" water were discussed at great length, and at a conference on the following day, 3 April, the technical staff and the Radiological Safety Section ruled out their use for this purpose.

As an alternate method of water sampling, the Bureau of Aeronautics commenced studies of the feasibility of a water

¹See Annex E: Safety Plan.

snatch from an aircraft and submitted the results to the technical staff. On 12 April, it was decided to abandon all efforts of this type and concentrate on the radio-controlled boats which the Bureau of Ships had meanwhile been investigating.¹ It was determined that the drone boats would involve use of TBM aircraft based on SHANGRI-LA, exercising radio control with visual sighting of the boats. During the planning of this program, the Bureau of Aeronautics Group gave technical advice and assistance to the Bureau of Ships Group in matters relating to the use of naval aircraft.

¹See Chapter 8: OTHER SPECIAL PROJECTS:
Drone Boat Program

SHIP PREPARATION PLAN

Target Aircraft

The planning and implementing of the Bureau of Aeronautics Group's program for exposure of naval aviation material was in support of the Ship Preparation Plan.¹ The Group planned static exposure of surplus aircraft and their components, with the aircraft in a condition of combat readiness, aboard various target vessels. From the plan of exposure it would be possible to determine the effects of the burst at graduated distances from the center to the periphery of the target array. The exposure of complete aircraft was coordinated with Army Air Force representatives of the Army Ground Group, which did not plan to expose complete aircraft of its own. The Group also took responsibility for investigation of the effects of the bomb upon certain ship installations normally under cognizance of the Bureau of Aeronautics, principally catapults, arresting gear, and crash barriers.

The general plan for the exposure of target aircraft involved the assignment of twenty surplus carrier type aircraft, fighters, scout bombers, and torpedo bombers, to SARATOGA; fourteen of the same to INDEPENDENCE; two each scout observation type aircraft to NEW YORK, PENNSYLVANIA, and NEVADA; one scout observation aircraft to ARKANSAS, PENSACOLA, and SALT LAKE CITY; two each fighter type aircraft to fourteen APA's; and two patrol bomber type seaplanes moored in Bikini Lagoon as part of the target array.

Embarkation Orders

Implementation of the target exposure plan for aircraft began in late January when the head of the Bureau of Aero-

¹See Annex W, App. III: Condition of Target Ships as to Aircraft Loading.

navitics Group made a survey, covering both continental and off-shore air stations, of the availability of surplus aircraft and equipment for target purposes, followed by preparation of a detailed embarkation plan. There was no time to wait upon final decisions as to positions of the various vessels in the target array, because much time was going to be required in the routine tasks of preparing target aircraft, ferrying them from preparation centers to embarkation ports, and securing them for sea on the target vessels. Accordingly, aircraft preparation and embarkation orders were issued upon an estimate, which later had to be modified only in minor details, of the most probable target array.

The basic plan contemplated the embarkation of all aircraft at continental shipyards as far as availability of ships permitted, and it was possible to carry out this plan for all combatant types. The first orders were issued to NEW YORK on 5 February, followed by orders to INDEPENDENCE, SARATOGA, SALT LAKE CITY, PENSACOLA, PENNSYLVANIA, NEVADA, and ARKANSAS, as rapidly as firm information on the port availability of these ships was received. The orders to carriers were more detailed because of the number of aircraft involved. A relocation of SARATOGA in the target array, with an increase in severity of exposure probably to the extent of serious damage to the flight deck aircraft on the first blast, required modification of her original orders by supplementary orders, dispatched on 20 February, to increase the hangar deck complement by six aircraft. SARATOGA was an important element in plans for aircraft exposure to the second blast, and the additional aircraft were loaded in the hangar deck for transfer to the flight deck after the first blast if necessary.

Continental Loadings

The two SC seaplanes for NEW YORK were flown by the Aircraft Delivery Unit of the naval air station at Norfolk to the naval shipyard at Philadelphia, where they were landed in the Delaware River, towed to the ship, and hoisted aboard.

West Coast activities provided all the other embarked aircraft. The OS2U-3 airplanes for the battleships and cruisers, provided by the naval air station at Seattle, were delivered to PENNSYLVANIA at the naval shipyard at Puget Sound, and to NEVADA, ARKANSAS, SALT LAKE CITY, and PENSACOLA at the naval shipyard at Terminal Island. The two airplanes for NEVADA has been painted international orange and yellow.

Carrier aircraft for SARATOGA and INDEPENDENCE were supplied by various Carrier Aircraft Service Units and other units of the naval air stations at San Diego and Alameda. INDEPENDENCE proceeded to San Diego to load her aircraft, which had been prepared there, and returned to Terminal Island. SARATOGA loaded her aircraft from the dock at the naval air station at Alameda. The naval shipyards at Puget Sound, Mare Island, and Terminal Island, as well as the naval air station at Alameda, assisted the West Coast target vessels in loading of aircraft and securing for heavy weather, also providing steel drip pans for the airplanes fueled to capacity on the after end of the flight decks of SARATOGA and INDEPENDENCE:

Pearl Harbor Loadings

Loading of aircraft on the remaining ships, all auxiliaries, was carried out at Pearl Harbor, where the APA's had been assembled. Since practically all combatant types were to be located near the target center, a line of APA's of the GILLIAM class, extending radially outward in the southwest quadrant, was selected as aircraft exposure stations to determine blast damage at graduated positions. Commander-in-Chief, Pacific Fleet, was alerted on 15 February to prepare twenty-four aircraft for embarkation on APA's which would be designated as soon as decisions had been made on the locations of these vessels in the target array. CinCPac subsequently passed this request to Commander Air Force, Pacific Fleet, for accomplishment. On 20 February, when assurance had been received of the probable firmness of the target array, embarkation orders were issued; minor changes in the target array at a later date necessitated two additional APA stations.

Seaplane Moorings

The original exposure plan calling for four patrol type seaplanes were reduced to two after ComAirPac advised that only two aircraft of this type were available in flying condition. ComAirPac was at first requested to prepare these two aircraft for delivery to Bikini by air early in May, but after the postponement this delivery was requested for late in June. Meanwhile, the Deputy Task Force Commander for Technical Direction had approved the mooring of these seaplanes in selected downwind locations at varying distances from the target center, so that no interference with the target ships would occur and fire hazard would be minimized. The Bureau of Aeronautics Group requested the Deputy Task Force Commander for Aviation to lay the moorings and to effect the air ferry. It was pointed out that rough water security should be emphasized in laying the moorings, as these aircraft must remain unattended in Bikini Lagoon for several days before Test Able, and that to reduce fire hazards these aircraft should arrive at Bikini with a safe minimum of fuel aboard.

Aviation Fuel and Lubricants

This program, of interest both to Army Ground and Air Forces and to the Bureau of Aeronautics, was executed by the Army Ground Group after agreement between both parties, with assistance from the Bureau of Aeronautics Group.¹ Because of the fire hazard to target vessels and embarked equipment, considerable concern was at first expressed over the initial proposal to expose limited quantities of fuel and lubricants. The proposal was taken up by the Working Committee of the Aeronautics Board. Officers of the Power Plants Division of the Bureau of Aeronautics met with this board and Army ground and air force technical representatives to draft a revised program acceptable to Commander Joint Task Force One.

¹See Chapter 6: SUPPORT OF ARMY GROUND GROUP PLAN: Quartermaster Unit.

Aviation Ordnance

The Bureau of Ordnance Group, which has cognizance of exposure of all ordnance materials, executed the plan for exposure of the blind loaded bombs, mines, torpedoes, and rockets with which selected target aircraft were armed.¹ The Bureau of Ordnance Group was also responsible for inspection, analysis, and report of this material. Working in close liaison with the Bureau of Aeronautics Group, the Bureau of Ordnance Group provided jury rigs for exposure of certain special gunsights and bombsights which are not standard equipment for the aircraft involved. Towards the last of March, the Bureau of Ordnance Group inspected the installation of equipment on SARATOGA's aircraft, comprising a Mark 23-Model O bombsight in the bombardier's compartment of a TBM-3E, a Mark 15 bombsight in the bombardier's compartment of another TBM-3E, a Mark I bomb director (AN/ASG-10A) in the cockpit of an SBF-4E, and a Mark 23-Model 1 gunsight in the cockpit of an F6F-5N. The Bureau of Aeronautics Group facilitated these installations.

Airborne Electronics

The electronics equipment normally installed in aircraft was considered an essential part of the general exposure plan. The program for the exposure of this equipment was carried out by personnel of the Airborne Coordinating Group of the Naval Research Laboratory assigned to the Electronics Group for that purpose.²

¹See Chapter 4: AVIATION ORDNANCE: Preliminary

²See Chapter 8: SHIP PREPARATION AND INSPECTION:
Airborne Electronics

INSPECTION PROGRAM

Preliminary Inspection in Shipyards

Soon after aircraft embarkation orders had been issued to the stations involved, the technical staff which had planned the aircraft target exposure program arranged for detailed inspections of the loaded targets. The inspection teams had representatives from each of the six aeronautical material units which comprised the Bureau of Aeronautics Group, and the inspections were to serve as indoctrinational training in inspection procedures for the members of the staff. Upon completion of loading of the two seaplanes in NEW YORK, the first inspection team from the Group proceeded to the Philadelphia Naval Shipyard to inspect and report on this equipment. In spite of heavy demands upon ships for other Cross-roads purposes, aircraft loadings in vessels on the West Coast proceeded on schedule, and on 12 March, the Bureau of Aeronautics Group departed from Washington by plane to conduct inspections of these loadings. Complete inspections of target aircraft on SARATOGA were made during 14 and 15 March at Alameda, California, and on INDEPENDENCE, SALT LAKE CITY, PENSACOLA, ARKANSAS, and NEVADA on 16 March at Terminal Island. Following these inspections which showed that all target aircraft loadings in continental ports were in accordance with embarkation orders, the Group returned to Washington.

The postponement of the first test provided time for refinements in planning and for making modifications in the exposure program for aircraft. It was necessary to consider additional preservative measures for certain embarked aircraft to prevent excessive corrosion and deterioration. Preservative measures were confined to the four fueled aircraft, exposed on the flight decks of SARATOGA and INDEPENDENCE, which were to be in a state of operational readiness. All other aircraft were adequately preserved for their missions. The Group initiated action to insure that qualified personnel would service these four aircraft with a daily engine turn-over by hand and a weekly engine run-up to maintain them in operating condition.

Late in April, the head of the Catapult and Arresting Gear Unit proceeded to Pearl Harbor to photograph and make preliminary inspections of the twenty-eight fighter aircraft loaded on the auxiliaries, and to complete the photographic record of the aircraft loadings made in West Coast shipyards. The remaining members of the Bureau of Aeronautics Group, who had embarked in WHARTON in early May with other Groups, made additional inspections of these aircraft after their arrival at Pearl Harbor.

Pre-Test Activities at Bikini

When the Group arrived at Bikini, there remained only a minor preparatory task to insure full readiness of the target aircraft for the tests. Members of the Group re-inspected all aircraft and removed covers, seals, and masking tape, which had been placed on the aircraft for preservation and prevention of tampering. In a number of aircraft, especially on SARATOGA and INDEPENDENCE, the Group installed VG recorders to measure the accelerations encountered by representative aircraft and placed empty sealed five-gallon cans in the cockpits. These cans were roughly representative of the size of a man's chest and would give an indication of the effect of the shock wave in crushing or collapsing the chest of an occupant. The Aviation Ordnance Unit assisted the Group in completing the exposure of inert ordnance equipment, including blind loaded and fuze bombs, torpedoes and rockets, and bomb sights on aircraft. The Airborne Electronics Section furnished three teams which energized and tested all aircraft electrical and electronic circuits. Two members of the Group flew to Ebeye in mid-June to assist in installation of a wire-recording apparatus to be used by the technical observer in PBM Charlie. On 20 June, the two VPB Coronado Seaplanes, which were to be moored in the Lagoon as targets, arrived at Bikini. Upon completion of flight tests and inspections of these seaplanes, all target aircraft in the exposure plan were in readiness for the Queen Day rehearsal.

All aircraft on the weather decks of target ships were inspected again after the fragmentation bomb burst on Queen

Day. Five aircraft on the flight deck of INDEPENDENCE and one on NEVADA were found to have been pierced by fragments resulting in negligible damage. The two large seaplanes which had been left in temporary moorings near Bikini Island during rehearsals, were moved to their permanent target moorings on 28 June. After making a photographic record of these planes, the Group reported all target aircraft ready for Test Able.

Test Able Operations

One member of the Bureau of Aeronautics Group was assigned to each Initial Boarding Team which was to inspect, upon re-entry, any target ships containing aircraft. This involvement in initial reboarding permitted an early analysis of damage to target aircraft after the Test Able bomb burst. On 3 July, the Group commenced its function as a single aeronautic inspection team and examined all target aircraft not previously covered by Initial Boarding Teams. These inspections furnished the additional data necessary for preparation of the Gross Damage Report, submitted on 5 July. Early reports indicated that the operation of Navy drones used for collection of samples from the atomic cloud, the photographic and observation missions from naval aircraft, and the use of helicopters for observation and collection of earth samples were all highly successful. The over-all damage to target aircraft was about as expected; a few aircraft were missing, sunk with ships or blown overboard, and those remaining received damaged in varying degrees which could be readily integrated as a function of the distance from the burst. By 13 July, the Group concluded the detailed inspections of aircraft and confirmed their plans for aircraft exposure in Test Baker.

Exposures for Test Baker

The general plan for exposure in the second test assigned four torpedo bombers and six scout bombers to SARATOGA;

one each of the same to INDEPENDENCE; two scout observation type aircraft to NEW YORK; one each fighter type to PENNSYLVANIA and seven auxiliaries; two each fighter type to seven other auxiliaries; and two patrol bomber seaplanes moored in the Lagoon as part of the array. The aircraft dispersed on the flight and hangar decks of SARATOGA were to be in a pattern similar to that used for Test Able, with the aircraft on the after-end of the flight deck fueled and in a state of operational readiness. The aircraft on battleships were on the main deck; those on auxiliaries were located topside on the upper deck. Where two aircraft were on an auxiliary, one was located topside, and the other was placed in the second platform cargo hold.

In anticipation of the high waves expected in Test Baker the Group requested ORCA to rig special additional mooring bridles for the seaplane moorings. Shifting of the target aircraft to locations on new target vessels was accomplished by SIOUX (ATF-75) and LST 989. In general, electronic equipment on target aircraft for Test Baker remained the same as for Test Able. The exposure of special items of ordnance equipment included special bombsights and four 500 pound blind-loaded bombs on SARATOGA aircraft, and blind-loaded rockets on aircraft on two auxiliaries. Critical items such as clocks, automatic pilots and life-rafts had been removed for return to aeronautic stores.

During Test Able, a number of aircraft in cargo holds of target auxiliaries had been damaged as a result of the pontoon hatch covers becoming dislodged and falling into the holds on the aircraft. To prevent recurrence of such damage in Test Baker, the Director of Ship Material approved a modification which directed that the hatches be secured by welded holding-down clips.

By 20 July, all aircraft were on their target ships, secured, photographed, inspected and ready for the test. The two seaplanes were moved to their test moorings on 22 July.

Test Baker Operations

The target area contained such radioactivity after the sub-

surface bomb burst that only a few ships on the outer periphery of the array could be inspected. Consequently, officers of the Bureau of Aeronautics Group returned from Initial Boarding Teams to WHARTON on the evening of 25 July to await developments; and during the next few days, these officers assisted in the early decontamination efforts. Sample accessories and instruments to be returned to the United States for laboratory analysis were recovered from aircraft on the six auxiliaries inspected by 3 August. While decontamination units continued to clear the ships, some members of the Group prepared the Gross Damage Report for Test Baker. By 10 August, the aeronautics inspection team had completed inspection of aircraft and handling equipment on all target vessels with the exception of INDEPENDENCE and FALLON. The decision was made to retain a number of aircraft, representative of the various degrees of damage incurred during both tests, for possible use by the Army Air Force Material Command at Wright Field, Dayton, Ohio. The Group selected five aircraft for this purpose and retained six additional aircraft for long range radiological studies by the Task Force Safety Section. Captain Lonnquest, the head of the Group, was released on 10 August for re-assignment and Captain Dodson assumed charge of the Group. Remaining inspections were finished by 17 August, when sample items of aviation materials to be returned for laboratory analysis had been collected. Some items were shipped, and others, radiologically unsafe for shipment, were placed aboard the LST 661 for towing to Kwajalein for storage. The Group arranged for later removal to Kwajalein of the eleven aircraft previously mentioned. The Interim Report on Test Baker giving all the technical information on the results of the sub-surface atomic bomb on aircraft was finished and submitted on 20 August. This completed responsibilities of the Group in the Bikini Area, and the Director of Ship Material released the Group on 23 August for return via air to its headquarters at the Navy Department in Washington, D.C., where they were to re-assemble about 12 September for preparation of the final reports.